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SOIL FUMIGATION

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Subterranean insects have always been the source of more or less embarrassment to the entomologist engaged in field crop insect investigations. In greenhouse management and truck crop growing very efficient treatments have been devised, as the intensive methods in these branches of agriculture make possible and profitable methods that in field crop farming, are prohibited by cost and labor. Among field crop pests, forms which complete their life cycles within one year and which transform more or less uniformly and contemporaneously, have been quite successfully combated by cultural methods. These same methods are also being generally recommended for such forms as wireworms (*Elaterid* larvæ) and white grubs (*Lachnosterna* larvæ) which spend more than one season in the soil as larvæ. These methods, although carried out most thoroughly, cannot, from the nature of the life histories of these pests, be efficient in less than two years and in the case of forms like *Melanotus* spp. in which the larval stage extends over three winters, three years of combative culture will be required to rid a field of the pest. It is with this knowledge that such recommendations are made, not because they are believed to be efficient but because no better treatment has, as yet, been brought forward.

In the following paragraphs will be outlined a radical departure

from the general line of remedial work against subterranean insects. This departure is soil fumigation and, inasmuch as we have only tried one fumigant, soil fumigation with sodium cyanide.

Three phases of any remedial measure always confront the investigator; first, will the remedy in question be efficient; second, will it be practicable and safe; and third, will it be economical. The work of the past season, which will be reviewed in detail later and which was carried on under the Office of Cereal and Forage Crop Insect Investigations of the National Bureau, proved the first of these phases affirmatively. The practicability of the treatment resolves itself into two questions, how shall we apply the fumigant, and when shall we apply it. The first question is being investigated by consultation with commercial chemists and manufacturers of farm machinery. The second question was partly solved by pot and field experiments this season. Four possible and practicable times of application present themselves: first, with the fertilizer at the time of seeding; second, drilling in with an attachment at the time of corn cultivation; third, at the time of fall ploughing; and fourth, at the time of spring ploughing.

The great danger attached to the use of cyanide on the farm, both to men and live stock, is, perhaps, the most serious negative factor that the initial work has faced and may ultimately render the treatment inadvisable.

Another serious factor in determining the final value of this remedial measure is its ultimate effect upon the microbiota of the soil. Recent botanical investigations have proved the interdependence of certain plants, notably the *Leguminosæ*, and certain bacteria. Investigators have also found other free living nitrifying bacteria in the soil and now believe that the fertility of the soil is largely dependent upon the activities of microörganisms. If the cyanide destroys these beneficial and necessary bacteria, reinoculation will be necessary after the cyanide treatment. However, that this absolute soil sterilization would be undesirable, is not as evident as it might seem on casual consideration. From the statements of Russel and Hutchinson of the Rothamsted Experiment Station (England) quoted by Prof. T. B. Wood in his presidential address before the Agricultural Section of the British Association for the Advancement of Science at Birmingham this year, the so-called soil toxicity, held to be caused by toxic substances produced by the crops themselves, is in reality not a soil toxicity but a soil impoverishment. The soil is depleted of its nitrifying bacteria by certain protozoa which feed upon these bacteria. These undesirable protozoa would be killed as well as their prey and reinoculation would be more than compensated by the vigorous development of the newly introduced bacteria in the absence of their depredators.

Mr. L. D. Larsen of the Hawaiian Sugar Planters' Experiment Station has found that protozoa are very abundant in Hawaiian soils and that soil fumigation with carbon bisulphid acted as a decided stimulus to crop production.

In the experiments so far carried on, the treatment has been so costly as to be prohibitive in actual farm practice. However, this is not to be regarded as a serious factor, for cyanide can undoubtedly be produced in a much cheaper form than that used in the trials, and smaller dosage with cheap filler will very probably make the treatment economically available.

The laboratory work was all carried on at the United States Field Laboratory located at Hagerstown, Md., and in this work Mr. C. M. Packard assisted materially. The field work was carried on at Wolfsville, Md., near Hagerstown, and at Bridgeport, N. Y., near Syracuse.

The laboratory work was started late in May by a series of pot experiments to determine the effect of the fumigant upon the crop to be treated. Corn was selected as the crop because it is probably more generally and seriously damaged by subterranean insects than any of the cereal and forage crops. The cyanide used in these experiments was not the c. p. sodium cyanide but a commercial mixture containing from 39 per cent to 40 per cent of cyanogen, the equivalent of 98 per cent to 99 per cent potassium cyanide. The mixture was as follows:

Sodium cyanide	74 per cent to 76 per cent
Alkaline chlorides	16 per cent to 24 per cent
Inert substances	2 per cent to 8 per cent

The pots used in all the laboratory work were unglazed earthenware flower pots six inches in diameter and six inches in depth. This size pot was selected because the general depth of ploughing is about six inches and by simply determining what fractional part of an acre was contained in the exposed surface of earth in a pot, the dosage could be roughly determined in terms of pounds per acre. The earth used in these experiments was ordinary corn field earth from a neighboring farm and the entire batch was thoroughly mixed to eliminate as far as possible all variables but those intentionally introduced. Three series were used, each series containing twelve pots divided into four groups of three pots each. In the first series (Division A) all the pots were seeded and treated on the same day, May 29. In the first group of three pots in this series no cyanide was used and the group served as a check. The second group contained one scruple of cyanide to the pot, roughly 300 pounds to the acre; the third, one dram, 900 pounds to the acre; and the fourth, two drams, 1700 pounds to the acre. In the second series of twelve pots (Division B) the cyanide dosage and

check were as in the first series but no seed was planted on the date of soil treatment. The treatment with cyanide in this series was on May 29. On June 10 one pot from each of the four groups in the series was seeded. On June 24 a second pot from each group was seeded and on July 8 the remaining pot in each group was seeded. The third series of twelve pots (Division C) was entirely seeded on May 29 but no cyanide treatment was made at the time of seeding. The first group of three pots was never treated with cyanide and, as in series *A* and *B*, served as a check. The second group was treated with cyanide, June 10, the same amounts being used as in the other series. The third group was similarly treated on June 24 and the fourth group was similarly treated on July 8. The accompanying tables are self-explanatory. The experiments showed conclusively that sodium cyanide cannot be placed in the soil at the time of seeding with the fertilizer and cannot be placed in the soil during the process of cultivation subsequent to seeding. These experiments also show that sodium cyanide is decreasingly poisonous up to from twenty-six to forty days after application, after which no appreciable difference can be found between treated pots and untreated checks, thus setting a margin of danger in seeding, after treatment with this fumigant, of forty days.

As laboratory results are always subject to discrepancies, due to necessarily artificial conditions, two field experiments were conducted at Wolfville, Md., and a third at Bridgeport, N. Y. The two field experiments, at Wolfville, Md., were conducted during the month of June. In one field cyanide, at the rate of about 300 pounds to the acre, was drilled into the corn hills by hand, simulating, as near as possible, the depth and distance from the plants that it would be drilled in by machinery when cultivating the crop. The corn in this field was planted on May 13 and the plants were about ten inches high when treated on June 6. Sixty-seven hills were treated. The field was again visited on June 18 and on that date every treated hill was killed out, the plants being dried up. In another field cyanide was applied at the rate of about 150 pounds per acre in the same manner as the above and when again examined on June 18 gave the same results.

The field experiments at Bridgeport, N. Y., come under two headings to answer the first and third phases of remedial measures as outlined in the third paragraph of this paper. Wireworms (*Agriot*...) were in the fields in enormous numbers, in fact so num... that application was made to our office for assistance. Corn was so badly infested that some fields were reseeded while all were "p... ed" as a result of the depredations of these insects. The general practice on the farms in this region, which are principally hay farms, is to keep land in sod for three years at least and, if it is still produ... g a fair

quality of timothy hay, to continue the sod for from five to seven years. The conditions are, therefore, ideal for experimentation of the nature under discussion. The farm on which we are working is level and remarkably uniform in the matters of soil and drainage, the latter, due to the contour, being artificial surface drainage by the method known as "land ploughing," that is, leaving a dead furrow every fifteen or twenty feet which drains into deep permanent ditches.

The wireworms were attacking several crops other than corn, among which might be mentioned potatoes, beans, carrots, wheat and mushrooms. Potatoes were riddled by these insects, as many as ten larvæ being found in a single tuber. As the worms were concentrated in the potato hills these were the first to be treated to determine the first and principal phase of the problem, namely, the efficiency, regardless of all other factors, of the remedy in question.

On October 1 cyanide was placed in fifteen hills by hand at the rate of 300 pounds per acre, the treated hills being consecutive in the row and with untreated hills on either side of the treated area. On October 4 three of the treated hills were dug out and examined. The larvæ were still numerous but inactive. They were in a very abnormal attitude, being distended and straight, presenting a rigid corpse-like appearance. Fifty of these larvæ were collected and placed in small tin boxes with moist sphagnum moss to determine whether they were actually dead or merely temporarily overcome by the cyanide. In several adjoining untreated hills all the larvæ were active and normally distended. Fifty of these larvæ from untreated hills were placed in boxes similar to the treated hill specimens as a check. At the end of three days the two groups of boxes were examined. The larvæ from treated hills were all dead and had started to discolor while the check specimens were alive and active. On October 9 the remaining treated hills were dug out, no living insects of any kind were to be found in the hills above the depth to which the cyanide had been introduced, i.e., six inches. Many dead larvæ were still to be found, while in all the remaining hills of the patch, examined when the crop was dug, living active larvæ were still feeding on the tubers. Thus was the first phase of the remedy conclusively proved in the affirmative. *Sodium cyanide will kill wireworms if correctly applied.*

The second experiment has not yet been concluded. It is being carried on in a 20-acre field which has been in sod since 1910. This field immediately adjoins the potato field in which the above experiments were carried on. A strip containing one twentieth of an acre, bounded on the east by the potato field before mentioned, on the west by a piece of fall plough sod similar to itself and on the north by a continuation of the same ploughing, has been treated by sowing, by

hand, finely crushed sodium cyanide at the rate of 500 pounds per acre. The pieces were approximately as large as a pea. This heavy dosage was applied in order to give striking and easily recognizable results. The cyanide was sown in the furrows and the sod turned on top of the poison. The ploughing was quite evenly seven inches and thus the poison was quite uniformly buried to this depth. All of the field will be planted to corn next spring. A strip, of about one-half acre area, was left in the field for spring ploughing and an area on this will be treated with cyanide at the time of ploughing. Across the field, at right angles to the ploughing and also the cyanide experiment, a strip is to be treated with lime at the rate of one ton to the acre. This strip will cross part of the cyanide treated area. The above experimental plat was arranged to throw light on the following questions, will sodium cyanide affect the soil chemically or physically, if so, will the effect be influenced by the time of treatment and time of ploughing, and will the cyanide be affected in its relation to the soil or in its relation to the insects by liming. Aside from the subject under discussion, the older remedial measure of culture will receive additional data.

The pertinent results of this season's work may be summarized as follows; first, sodium cyanide will not permanently injure the soil; second, it cannot be applied while the crops are on the land nor immediately prior to seeding, and third, it will kill wireworms.

LABORATORY EXPERIMENT WITH SODIUM CYANIDE—DIVISION A

Division	Pot Number	Insecticide Treatment		May 29	June 10	June 15	June 24	July 8	July 15	[illegible]
		Amount	Date							
A	1	None....	May 29..	Seeded...	4 sprouts.	5 plants..	5 plants..			
	2	None....	May 29..	Seeded...	3 sprouts.	6 plants..	6 plants..	Discontinued this [illegible]		
	3	None....	May 29..	Seeded...	2 sprouts.	2 plants..	2 plants..			
	4	1 scr.....	May 29..	Seeded...	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted
	5	1 scr.....	May 29..	Seeded...	"	"	"	"	"	
	6	1 scr.....	May 29..	Seeded...	"	"	"	"	"	
	7	1 dram ..	May 29..	Seeded...	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted
	8	1 dram ..	May 29..	Seeded...	"	"	"	"	"	
	9	1 dram ..	May 29..	Seeded...	"	"	"	"	"	
	10	2 drams..	May 29..	Seeded...	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted
	11	2 drams..	May 29..	Seeded...	"	"	"	"	"	
	12	2 drams..	May 29..	Seeded...	"	"	"	"	"	

CONDENSED RESULTS OF DIVISION *A* OF POT EXPERIMENTS

Pot Number	Treatment	Percentage of Living Plants at End of Experiment
[illegible]	Check	72%
[illegible]	1 scr.	0%
[illegible]	1 dram	0%
[illegible]	2 drams	0%

LABORATORY EXPERIMENT WITH SODIUM CYANIDE—DIVISION *B*

Division	Pot Number	Insecticide Treatment		May 29	June 10	June 15	June 24	July 8	July 15	July 26
		Amount	Date							
B	1	None	May 29		Seeded	1 sprout	1 plant	1 plant	1 plant	1 plant.
	2	None	May 29				Seeded	5 plants	5 plants	5 plants.
	3	None	May 29					Seeded	5 plants	5 plants.
	4	1 scr.	May 29		Seeded	1 sprout	1 plant	1 plant	1 plant	1 plant.
	5	1 scr.	May 29				Seeded	1 plant	1 plant	1 plant.
	6	1 scr.	May 29					Seeded	5 plants	5 plants.
	7	1 dram	May 29		Seeded		1 plant	Died	No plant	No plant.
	8	1 dram	May 29				Seeded	3 plants	3 plants	3 plants.
	9	1 dram	May 29					Seeded	6 plants	6 plants
	10	2 drams	May 29		Seeded		No plant	No plant	No plant	No plant.
	11	2 drams	May 29				Seeded	2 plants	2 plants	2 plants.
	12	2 drams	May 29					Seeded	4 plants	4 plants.

CONDENSED RESULTS OF DIVISION *B* OF POT EXPERIMENTS

Pot Number	Seeded	Percentage of Living Plants at End of Experiment
[illegible]	Check	61%
4-7-10	12 days after treatment	5%
5-8-11	26 days after treatment	33%
6-9-12	40 days after treatment	83%

LABORATORY EXPERIMENT WITH SODIUM CYANIDE—DIVISION C

Division	Pot Number	Insecticide Treatment: Amount	Insecticide Treatment: Date	May 29	June 10	June 15	June 24	July 8	July 1[illegible]
C	1	None.		Seeded	5 plants	5 plants	5 plants	5 plants	5 plants
	2	None		Seeded	6 plants	6 plants	6 plants	6 plants	6 plants
	3	None		Seeded	6 plants	5 plants	5 plants	5 plants	5 plants
	4	1 scr.	June 10	Seeded	4 plants[1]	....	All dead	....	
	5	1 dram	June 10	Seeded	6 plants[1]	....	All dead	....	
	6	2 drams	June 10	Seeded	5 plants[1]	....	All dead	....	
	7	1 scr.	June 24	Seeded	6 plants	6 plants	5 plants[1]	....	All dead
	8	1 dram	June 21	Seeded	2 plants	2 plants	2 plants[1]	....	All dead
	9	2 drams	June 21	Seeded	6 plants	6 plants	6 plants[1]	....	All dead
	10	1 scr.	July 8	Seeded	6 plants	6 plants	6 plants	6 plants[1]	......
	11	1 dram	July 8	Seeded	6 plants	6 plants	6 plants	6 plants[1]	......
	12	2 drams	July 8	Seeded	5 plants	5 plants	5 plants	5 plants[1]	......

[1] Indicates date on which cyanide was applied.

CONDENSED RESULTS OF DIVISION C OF POT EXPERIMENTS

Pot Number	Treated with Cyanide	Percentage of Living Plants at End of Exp[illegible]
1-2-3	Check	88%
4-5-6	12 days after seeding	0%
7-8-9	26 days after seeding	0%
10-11-12	40 days after seeding	0%

Colonel William C. Gorgas, Surgeon-General of the United States Army [illegible] the honorary degree of Doctor of Science from Princeton on June 16, and [illegible] of Laws from Yale University on June 17. In presenting him for this hon[illegible] Professor Cross spoke as follows:

"William Crawford Gorgas, Surgeon-General of the United States [illegible] is needless to rehearse the career of General Gorgas. As chief sanitar[illegible] Havana, he entered into a close fight with yellow fever and drove that di[illegible] the Cuban capital. As medical director of the Panama Zone, his applica[illegible] lessons of science to practical hygiene and sanitation made possible the [illegible] of an immense engineering project. In recognition of his splendid achie[illegible] has been honored at home and abroad by degrees, medals, and men[illegible] scientific societies—and most impressively by his recent call to South A[illegible] prove the sanitary conditions in the mining district of the great Wit[illegible] To General Gorgas, as to few others, has been allotted the extreme di[illegible] having the story of his achievements become a part of current history [illegible] mand the admiration of the civilized world. Of old, this honor came to [illegible] who left blood and slaughter in their trail; it has come to General Gor[illegible] unnumbered lives he has saved."

SOME FACTORS AFFECTING RESULTS IN THE USE OF HIGH TEMPERATURE FOR THE CONTROL OF INSECTS INJURING CEREAL PRODUCTS

By W. H. Goodwin

In some experiments in treating flour mills using heat, several failures were experienced when apparently sufficient radiation had been installed. These mills had proportionally as much radiation as similarly constructed mills in which excellent results had been obtained. A careful survey of these mills failed to disclose any lack of steam pressure; neither was the failure due to only partial circulation of steam in the radiator coils; nor to a greatly reduced opening in the steam pipes leading to the heating coils. In one or two mills a lack of steam pressure owing to the small or greatly reduced passage ways of the steam mains, or feed pipes, was readily discovered and the trouble soon remedied. In two flour mills, however, leaks in the heating coils produced an extremely moist atmosphere, and although the temperature was high enough to kill most of the stages of the Mediterranean flour moth, especially the small larvæ, many of the other minor mill pests survived and appeared to be none the worse for having been heated. The temperatures attained, 45°C. to almost 47°C., were high enough to kill many of the insects present, but, apparently, on account of the relatively high humidity many survived. These insects which survived the test were not greatly disturbed, even when the duration of the heating period was greatly lengthened. The heated atmosphere did not seem to penetrate very deeply into any collections of flour which occurred in machines or in conveyors in which these insects lived. The treated insects which survived acted perfectly normal after the test, and reproduced normally later in the year. This appeared to disprove the practical efficiency of high temperature for the control of cereal insects, unless a greatly increased amount of radiation was provided.

The amount of radiation present, already exceeded the requirement for similarly constructed flour mills, in which excellent results had been obtained. The only factor which appeared to be responsible for the apparent difference and that was preventing the necessary rise in temperature above 45°C. to the fatal temperature for most insects, 48°C. to 52°C., was the extreme humidity of the heated atmosphere. The thermal conductivity of the wood floors being very small, the evaporation was not rapid, but the amount of heat absorbed by the evaporating water cooled the atmosphere in the mill being treated to such an extent that the necessary rise in temperature above 45°C. to the fatal

temperature, 48°C. to 52°C., could not be attained. This temperature kills all stages of the cereal pests that I have tried in laboratory experiments, excepting the young larva of *Trogoderma ornatum*, which often requires 53°C. to 54°C. before succumbing to the effects of heat.

In one flour mill all the return pipes from the heating system emptied into open condensing tanks in the basement of the mill. The heating of this mill was a partial failure, apparently due to the humid atmosphere and also to not being properly equipped with steam traps or condensers, so that a steam pressure of 40 to 60 pounds could be used in the entire heating system.

Soon after these failures to obtain the fatal temperature, experiments were begun to substantiate or disprove this relative humidity theory. A small water-jacketed oven was pressed into service; several small hygrometers, some of which later proved to be inaccurate, and a gas burner and some accurate thermometers completed the first set of apparatus. A large series of tests using this oven, placing therein the insects and material treated in small glass vessels with brass-cloth lids to confine the insects, gave results which seemed to substantiate the humidity theory. These results were not technically exact, hence they need no further comment, excepting the fact, that they proved that moisture is a very important factor when using high temperatures for the control of the insects affecting cereals and cereal products.

The amount of heat required for a dry-atmosphere, high-temperature test was much less than for an extremely moist-atmosphere test, demonstrating the necessity for more careful and exact experiments along these lines, and proving in a rough way that the leaks in the heating system and wet floors were responsible for the partial failures mentioned.

Later, a small water-jacketed oven with an air-space surrounding the water-jacket was procured and better grade hygrometers, besides the wet and dry bulb thermometers, and an apparatus was devised for circulating the air in the oven around the wet bulb thermometer. Brass wire-cloth containers for the insects and material were also constructed in order to get more exact and uniform conditions throughout the oven, and in the material treated. These small wire-cloth containers permitted the passage of the air through their walls and so the rapid escape and ingress of moisture. It permitted the humid air in the moist-atmosphere tests to come in direct contact with the insects being treated, allowing very small chance for error. A series of experiments were made, taking into consideration the previous experiments and avoiding, as far as possible, the discrepancies which occurred in the first series of tests.

The inner walls of the incubator oven were covered with blotting

paper saturated with water, thus completely preventing condensation when making moist-atmosphere tests, and insuring a very humid atmosphere. In dry tests this was removed. An atomizer throwing hot water, was used without success, as was also small amounts of live steam. The special burner was modified so that small amounts of gas could be used with a low flame and consequently the rise in temperature in the oven was necessarily extremely even and slow. The gas pressure proved to be too strong and a pressure reducer was therefore devised to reduce the gas pressure from eight ounces to one-half ounce. A good grade of machine oil was substituted for the water which is ordinarily used in such a pressure reducer. The regulator was adjusted until the pressure was sufficiently reduced to require no further attention as the machine oil does not evaporate. A large Mithoff hygrometer, reading direct, was used to register the percentage of moisture present. These readings were checked by the use of a wet and dry bulb thermometer and the results were calculated from the psychrometric tables of the United States Weather Bureau. A wet bulb thermometer will not register the minimum temperature correctly, unless the air is circulated around it. To obtain this circulation some device that will circulate the air around the wet bulb thermometer is required. An electric bell was modified for this purpose by removing the ball from the vibrator arm and replacing it with a small fan made from light, soft wood. This modified electric bell was operated with two dry batteries, and the rapid vibration of the fan blade circulated the air around the base of the thermometer.

The following list of species were used in these experiments:—

Silvanus surinamensis L.	*Sitodrepa panicea* L.
Cathartus advena Walt.	*Tribolium confusum* Duv.
Cathartus gemellatus Duv.	*Tenebrio molitor* L.
Laemophlæus minutus Oliv.	*Plodia interpunctella* Dubn.
Trogoderma ornatum Say.	*Ephestia kuehniella* Zell.
Alphitobius piceus Oliv.	*Calandra oryza* L.
Tenebrioides mauritanicus L.	

In the oven experiments most of the different species of insects succumbed at a slightly lower temperature when using moist heat than when using dry. The rice weevil (*C. oryza*) seemed to be especially susceptible to heat in a moist atmosphere, repeated tests showing that 3° to 4° C. less are required to prove fatal than when using dry air. Several of the other species died at practically a uniform temperature, regardless of the presence or lack of moisture. Considerable variation in the moisture content of infested material and in the activity of the insects infesting the same was also experienced. In the tests most of the insects became very active at 40° C. to 43° C., especially the adults. This activity increased with the increase in

temperature until they became frantic in their efforts to escape. The high temperature speedily caused death. A lowering of the temperature previous to attaining the fatal degree generally brought about almost normal actions though, in some cases, a period of inactivity resulted before normal activities were resumed. This period of partial inactivity sometimes lasted several days before all of the functions were performed in an entirely natural way. In many cases, especially when a dry atmosphere at 47° C to 48° C. was used, the insects surviving the test would die several hours to several days later. In making a large number of tests it was observed that very often the different stages of the same species, succumbed at slightly different temperatures. In every case, as far as these experiments extended, the egg stage was the first to be destroyed. The resistance of the stages varied with the insect, but in general that stage which endured the greatest heat, or sometimes survived, was usually the dormant one in which the insect passes the winter. In those cases where all stages occur at all seasons, little difference in resistance could be discerned, but in the case of *T. ornatum*, the partially grown, or young larva, readily survived a temperature which proved fatal to the other stages.

Silvanus surinamensis was not much more susceptible to moist than dry heat. In a large series of experiments the fatal temperatures with moist and dry heat were not more than 1° C. apart, and the average was a little less than .41 of a degree Centigrade. The egg stage was killed in every case by 44° C. to 45° C.; 44° C. being the average temperature which destroyed life in the egg. Larvæ, pupæ and adults died at 46° C. to 48° C., the pupæ proving more susceptible to heat than larvæ or adults. The beetles withstood treatment longer and also a slightly higher temperature. This beetle is almost a universal feeder, being able to live and reproduce in wheat, flour, corn meal, breakfast foods, crackers, currants, raisins, dried fruits and nuts of several kinds, if the shells are broken. With the exception of *Tribolium confusum*, it is probably the most common and destructive pest affecting cereal products and ground cereals. It is not partial to the end or corner of a package of cereal, as are some other species, but works through the entire mass, nibbling here and there and rendering all of it unfit for food.

Cathartus advena lives almost entirely on ground cereals, but may often be found in stored grain in company with other species of *Cucujidæ*. It rarely occurs in great numbers, but it is one of the commonest stored-grain pests. A moist, heated atmosphere kills this beetle at almost 1° C. lower temperature than when it is subjected to dry heat. Like *S. surinamensis*, it does not always recover from the effects of being subjected to a dry, heated atmosphere, often dying several hours

or days after the test. While it may not be killed outright by the heat, certain of its tissues, or organs, seem to become fixed, failing to perform their normal functions, and this causes death some time after the actual treatment.

Cathartus gemellatus, a closely related species, seemed to be affected similarly by heat; the fatal or killing temperature being the same, and the final results very nearly the same.

Laemophlœus minutus. These tiny beetles are hard to kill, almost 50° C. being necessary. The larvæ and pupæ were killed by 48° C. to 49° C., and no eggs hatched after being treated to 45° C. These small beetles are among the most difficult of the *Cucujidæ* to kill with high temperature, but almost no difference could be detected between the effects of moist and dry heat, the average difference in effective temperature being less than .25 or ¼ of a degree Centigrade. They commonly occur in flour, corn meal, cereal products, nuts, raisins and sometimes in dried fruits. They are so small and flat that they easily find entrance beneath the lids of all but the closest fitting canister tops, and thousands of individuals will often be found in a few ounces of food material. Several scores of individuals were found living in a chestnut from which the larvæ of *Balininæ* had emerged.

Trogoderma ornatum. The young larva of this *Dermestid* survived most of the tests, being seemingly much better fitted to resist extremely high temperatures than the other stages of this insect. It is much more resistant than any other of the species of cereal pests, as far as these have been tested by the author. The young larvæ become very active at 45° C. to 47° C. and continue their activities with irregular periods of inactivity until a temperature of 52° C. to 53° C. is attained. At 52° C. the young larvæ begin dying and usually are all dead before a temperature of 53° C. is attained. The beetles, pupæ and full grown larvæ were readily killed by 48° C. to 50° C. Moist atmosphere at 48° C. to 50° C. was fatal to the beetles, pupæ and full grown larvæ, but was no more effective than a dry atmosphere at similar temperatures. This species will subsist on corn meal, popcorn, sweet corn, nuts, feathers, skins, museum specimens of birds, mammals, insects, etc., furs, woolens, and is almost a universal feeder.

Sitodrepa panicea. The drugstore beetle is readily killed in all stages by 47° C. to 49° C., there being apparently no difference between the effect of a heated moist or a heated dry atmosphere. This beetle is of special importance as it is truly a universal feeder on dried herbs, roots, grains, cereal products, and drugs of many kinds. It is a pest of the herbarium and museum, besides being a common drugstore pest. It may eat leather, if no other food is present, and it has, in a few instances, almost destroyed horn scoops in boxes of drugs where the

scoop was covered with some drug for several months, and was not disturbed or moved.

Tenebrioides mauritanicus and *Tenebrio molitor*. The cadelle beetles are readily killed by 48° C., but the larvæ will often live until a temperature of almost 50° C. is attained. Moisture, or the lack of moisture in the atmosphere, does not seem to make any radical difference. The beetles of the cadelle, and also the darkling beetles, are killed by 47° C. to 48° C., but the larva of the former is more resistant and a higher temperature is required to destroy it. The larvæ of *T. molitor*, however, are more susceptible to heat in the presence of moisture than in its absence. Larvæ of *T. molitor* died at 46° C. to 48° C.

Tribolium confusum. The confused flour beetle is killed by 48° C. and the moisture content of the heated atmosphere seems to make very little difference in results. The slight difference in favor of the moist atmosphere is not sufficiently large to be of any advantage. In fact, taking into account the slower rise in temperature in moist air, the obstruction to the penetration of heat, and the consequent difficulty in obtaining a fatal or killing temperature, the dry atmosphere is preferable. The eggs, larvæ and pupæ are all more readily killed than the adults by the dry heated atmosphere. The adults recover rapidly from the effects of heat if they survive. The larvæ and pupæ sometimes survive the dry-heat treatment if the killing temperature is rarely or scarcely attained, but all die subsequently, even if transferred to a moist food supply. Larvæ and pupæ which survive a similar temperature in a moist atmosphere seem in no way inconvenienced by the treatment they receive, and develop normally. When the confused flour beetles are placed in the oven with a quantity of flour, or middlings, they leave the surface of the material, burying themselves in the cooler parts of their food supply as the temperature rises. When the mass begins to heat through, they attempt to escape the heat by crawling out of the material and soon die on the surface of their food at 47°C, to 48°C. The time required for the heat to penetrate the middlings, or food supply, varies with the material to be treated, its moisture content and also with the intensity of the heat. Flour on the metal bottoms of conveyors will heat through in 3 to 5 hours if the surrounding atmosphere is heated to a temperature of 55°C. to 60°C. The flour in the conveyors is often 2 or 3 inches deep, so these insects would not be affected by any fumigants except the heavy penetrating gases, and would need to be subjected to these for long periods.

Plodia interpunctella. The Indian meal moth is readily killed by high temperature, 46°C. often proving fatal to larvæ, pupæ and adults, if continued for several hours. A habit of this species, that of working

near the surface of infested material, especially ground cereals, and also of pupating in similar places or near the confining walls, makes heat an especially effective means for destroying these insects. Dry heat was more effective than the moist heated atmosphere, as some of the individuals would recover after being subjected to a moist heated atmosphere; the heat and lack of moisture seemingly fixing the tissues more readily than when moisture was present.

Ephestia kuehniella was readily killed by either a moist or dry heated atmosphere. The eggs and young larvæ were destroyed if actually subjected to 45°C. to 46°C. for 15 to 20 minutes. The other stages were killed if subjected to 47.5°C. to 48°C. for a similar period of time. In many respects it resembled *P. interpunctella* in the effects of heat treatment. Its habits of living in the machines, elevators, spouts and conveyors in the center of the mill, make the dry atmosphere high temperature a very effective means for its control.

Conclusions and Practical Applications

The practical value of high temperature at 48°C. to 50°C. for the destruction of pests affecting cereal products is much lessened when the heated atmosphere contains moisture in proportions greater than 40 per cent to 50 per cent. In practical work, if the moisture content of the heated atmosphere remains constant, or is greatly increased as the temperature rises, an increase, proportionally, in the amount of radiating surface will be necessary in order to maintain and raise the temperature to the fatal or killing point. Throughout the series of experiments, the extreme difference in the quantity of gas required to heat the oven during a dry heat test and to heat it during a moist heat test was especially noticeable. The most careful estimates, based upon the pressure of gas and the rapidity of its flow through a known diameter opening, indicated that the extremely moist atmosphere tests sometimes require almost twice as much gas as the extremely dry atmosphere tests. Careful measurements with adequate instruments may discredit these estimates in part, but that an extra amount of radiating surface is required, or that an excess of fuel is required to heat the moist chamber, cannot be doubted. The latent heat absorbed in vaporizing water accounts for these results. A fairly moist atmosphere at 47°C. to 50°C. will prove fully as effective as the dry heated atmosphere, but is not practical for use because of the difficulty in obtaining 50°C. under moist conditions. The excess of radiating surface required to heat the buildings to the killing temperature, increases the cost of the heating plant, but sometimes it may be necessary. All leaks in the heating system allowing water or steam to escape into the rooms being heated should be repaired, especially if

the amount of radiating surface approaches the minimum. Our tests can only be taken as indicative of the general results that should be obtained in practical work in mills. Definite statements based on a specific laboratory test cannot be relied upon as general and the conclusion must be reached as a whole, after allowing for normal variations. The fact that a moist atmosphere at a high temperature is very effective for the control of a few cereal pests, does not make it preferable to dry heated air for practical use in a commercial way. The excessive amount of radiating required to produce a killing temperature under moist conditions makes economy of equipment a much more important factor. It also means the choosing of a very warm day, as the time to heat up the average flour mill. Leaks in the heating system also mean almost sure failure unless they are extremely small. Very few of the species of insects treated were more seriously affected by the moist heated atmosphere than by a dry one, and in those cases where the former was effective at a lower temperature, the penetration or conductivity did not appear to be as rapid as in tests of the latter kind. A further deterrent to the practical use of a moist heated atmosphere is that the least injurious of the flour mill pests are the only ones advantageously controlled by this treatment. The rice weevil is an exception, as it succumbs in a moist heated atmosphere at 3°C. to 4°C. lower temperature than in a dry heated atmosphere.

Rice mills could readily be treated by the heat method and the rice weevil thus destroyed. In case of reinfestation, the treatment could be repeated and much injury prevented. The cost of treating once every month would not be prohibitive. If the flour, or cereal mill, is so located that it is very moist during the summer, special provision should be made for abundant radiation so that the mill can be readily heated to the required temperature.

Summarizing our conclusions, oven experiments demonstrate that 50°C. to 55°C. kills all stages of cereal insect pests if they are actually subjected to this temperature for one to two hours. Further than this, in practical work, moisture conditions are extremely important and must not be overlooked, as failure to obtain the necessary temperature is often due to lack of sufficient radiating surface to overcome the excessive moisture conditions. Because of the more rapid radiation obtained, the use of steam at 50 to 60 pounds pressure will give results superior to those gotten with 8 pounds pressure with one-fourth more of radiating surface.

A steam pressure of 100 pounds can be used if the heating system is constructed of new piping. However, considering the danger of a break in the average heating system with cast radiators, or second-hand pipe coils, 50 to 60 pounds is the maximum steam pressure that

should be used. The temperature of steam at different pressures is about as follows:

10 lbs.	115°C.	60 lbs.	153°C.
20 "	126°C.	70 "	158°C.
30 "	135°C.	80 "	162°C.
40 "	142°C.	90 "	166°C.
50 "	147°C.	100 "	170°C.
55 "	150°C.		

It is thus seen that the rise in temperature from 10 pounds to 55 pounds is much greater than from 55 pounds pressure to 100 pounds. Maximum economy of heating will, therefore, be obtained by using a pressure of about 50 to 60 pounds, since this will give the temperature necessary to kill, rendering it both unnecessary and wasteful to go higher.

Furthermore, in heating work, no allowance has hitherto been made for the differences in heat conductivity of the various building materials. When we have taken all of the aforementioned points into consideration, definite factors for proportional amounts of radiation will be estimated for the various kinds of buildings, basing these factors on the results obtained in a large number of practical experiments.

The records of a few sample oven tests are appended:

MOIST HEAT

Time	Temperature C.	Moisture Per Cent
8.00	20	40
9.00	25	48
9.30	27	57
10.00	29	60
10.30	31	65
11.00	34	66
11.30	37	68
12.30	40	69
1.00	42	69
1.15	43	70
1.30	45	71
1.45	48	70
2.00	49	70
2.30	50	70
3.45	50	70
4.00	50.5	70

C. oryzæ. Larvæ and adults.

Some beetles apparently dead at 43° C. Many were dead before a temperature of 45° C. was attained. Larvæ removed from grains of corn, exposed to the heat, were also dead at 44° to 45° C. *S. surinamensis.* Adults and larvæ.

Both stages died between 46° C. and 48° C.

DRY HEAT

Time	Temperature C.	Moisture Per Ct.
8.00	27	34
10.00	36	28
10.30	42	26
11.00	42.5	25
11.10	43	24
11.20	43.5	25
11.30	44	23
11.45	45	22
12.00	46	23
12.15	47	24
12.45	48–	25
1.00	49	25
1.15	49	24
1.30	49.5	23
1.45	50	23
2.00	50.5	23
2.30	51	22
2.45	51.5	21
3.00	52	20
3.15	51.5	19
4.15	49.5	18
5.00	48	16

C. oryzæ. Adults, beetles died at 47° C. to 48° C.
S. surinamensis. Adults died at 48° C. to 49° C.
Mites *T. americanus*, were killed by 47° C.
T. ornatum. Larvæ half grown, adults and pupæ. Half grown larvæ died at 51° C. to 52° C. Pupæ and adults killed by 50° C.

THE WESTERN CORN ROOT WORM

By George G. Ainslie, *Entomological Assistant*

So many of the pests of orchard and field crops in the north and west have come, by importation and diffusion, from the east and south, it seems but just retribution that at the present time one of the well-established pests of corn in the west, *Diabrotica l*[illegible], the Western corn root worm, is invading the southeast from its original headquarters in Illinois and Missouri.

Prof. F. M. Webster has followed this species from the beginning of his entomological work, a period of forty years, and has watched its spread from an area, at first apparently small, in the prairies of Illinois until, at the present time, it "occurs from Nova Sc[illegible] south-ward to Alabama and Mexico, westward to southern Minnesota and South Dakota and thence south to southern New Mexico. Apparently it has not yet completed its travels, for the wri[illegible] within

the past year, added to its previously reported limits of distribution in southern and eastern Tennessee, northern Alabama and eastern Kentucky.

Although the identity of the original food plant of this beetle is as yet an unsolved mystery, corn now seems to be its sole dependence. This fact in itself affords a strong hope of relief from its ravages. Crop rotation, where possible, had proved almost without exception, a complete remedy. There yet remains, however, a problem to be solved. Along the Cumberland and Tennessee Rivers in Tennessee and northern Alabama and along the Arkansas, Mississippi and Ohio Rivers as well as many of the smaller tributaries of each, are large areas of rich bottom land subject to an almost certain annual overflow. This excess of water seems to have no deleterious effect whatever on the eggs which pass the winter in the earth of the corn fields. In one case which came under the observation of the writer, a portion of the bottom land along the Duck River in middle Tennessee was under water eleven times in one winter, each time for from 2 to 12 days. The larvæ were as numerous the following summer in this portion as elsewhere.

This overflow does, however, prohibit the growing of any but summer crops. The present southern limit of distribution of the species is within the cotton belt and in this district cotton and corn can be alternated on such lands. Farther north, the systems of farming generally followed demand that corn follow corn in the bottom land. Here it is that these larvæ do, and will continue to do, damage until some crop can, occasionally at least, take the place of corn, or some other method of control can be found.

The life and seasonal histories of the species have been almost completely worked out in Tennessee and found to be substantially the same as farther north. There is but one annual generation, the eggs being which pass the winter in the earth. They are laid in late July, August and September in the ground about the bases of the corn plants, especially in the small crevices among the brace roots. They hatch in late May or early June of the following year and the larvæ are most active and injurious in late June and early July. A drought at this time will increase the resultant damage to a considerable extent. The beetles begin to appear in July and, in infested fields are to be found in countless numbers during the following two months feeding on the fresh corn silk and pollen. The most serious damage, of course, is caused by the larvæ, which, by feeding on and in the small roots weaken and dwarf the plant, sometimes to such an extent that it may be easily discerned, at others only enough to reduce its yielding power without deforming it. When sufficiently numerous,

the beetles cause serious injury as well as the larvæ. The corn crop for the year 1910 was almost a total failure in the Duck and Tennessee River valleys in middle Tennessee. The ears developed good size, but, because the silk was eaten off by the beetles as fast as it appeared, pollination and fertilization were interfered with and many cobs bore but a few scattered kernels or consisted mainly of a long naked tip which never filled.

The structure and habits of the newly hatched larvæ have never been observed. It is not known how far or fast the larvæ at this stage are able to travel through the earth. We have at the laboratory at Nashville, Tenn., several hundred eggs which we are attempting to carry alive through the winter for the purpose of studying these particular questions. These eggs were obtained from beetles kept in captivity in vials and supplied with fresh corn silk for food. The eggs are so small and laid so scatteringly that after the field has once been plowed or disked or covered with water, to find them would make the hunt for the proverbial needle in a haystack seem a bit of child's play.

It behooves all entomologists, especially those of the Gulf and South Atlantic states, to watch for this insect and give warning of its approach. Otherwise it may cause widespread loss before the farmer realizes the cause.

RED SPIDER CONTROL

By E. A. McGregor

The common red spider of the United States has been accepted as *Tetranychus bimaculatus* since Harvey distinguished it by that name in 1893. Professor Berlese of Italy upon a few occasions has identified material of the *bimaculatus* type from this country as the European species *telarius*. It is with great hesitation, however, that Berlese's determination should be accepted since his published figures of the specific characters of the European species show a very different type from that exhibited by the American species.

With the exceptions of limited occurrences on fruit trees in western Colorado, and of considerable injury to hop fields in central California, no red spider complaints of a serious nature have come to our attention other than from the southeastern portion of the cotton belt. It is concerning its occurrence on cotton, then, that the present discussion of the pest is primarily centered.

Since the red spider is not an insect, it would be fair to presume in advance that certain factors bearing on its control should be radically

different from those commonly obtaining in the realm of insect pests. This, moreover, is found to be the case. The red spider is a gregarious, non-flying, non-hibernating, suctorial, phytophagous pest. It differs from the typical insect pest in that it remains active through the winter, is incapable of dispersion by flight, and in the limitation of the individual in its feeding operations, practically, to the immediate scene of its birth. The red spider, then, from the standpoint of biological characteristics, is to be likened most, perhaps, to the homopterous Hemiptera as a group and, naturally, the direct combative measures employed against the mites are somewhat similar to those used against such families, for example, as the Aphididae and Coccidae.

The absence of flight in the case of the red spider is a factor working greatly to the advantage of the agriculturist. It is a handicap against rapid dispersion which, try as it may, can never be overcome by the group. The means of spread are chiefly three:—first, through the agency of accidental transportation by other creatures; second, by the actual locomotion of the individuals themselves; and third, by hydro-locomotion.

It has long been recognized that larger insects, birds, domestic animals (especially plow animals at the time of cultivation), etc., served occasionally to transport mites from plant to plant. This, however, I do not consider a potent factor in the serious spread of the pest. It has likewise been observed that red spiders travel from plant to plant along branches which are in contact with one another. Mr. Worsham, in his bulletin on the subject, emphasized this method as the only means of spread which he observed. It has been determined in South Carolina, however, that mites also travel on the ground from stalk to stalk, the average rate being about one inch per 15 seconds. It appears established, though, that the great bulk of continuous dispersion is effected mainly by means of travel from plant to plant across the interlacing branches.

It had been difficult until this year to explain, however, in what way isolated spots of infestation came to exist in fields rather remote from the presumed source of dispersion. Observations conducted the past season at Batesburg, S. C., by Mr. McDonough and myself, have brought to light a new type of dispersion which seems unique, and we have called it hydro-locomotion. This factor easily accounts for most cases of sporadic infestation. It has been known for years that heavy rains are effective in washing off many red spiders to the ground. It was taken for granted that these washed-off mites were thus destroyed and eliminated for all time. It is known now, however, from experiments of the past season, that nine hours complete submergence is necessary to insure the death of the red spiders by water. The appli-

cation of the hydro-locomotion idea comes about, then, as follows: Battered to the ground by a heavy downpour of rain, countless thousands of mites are carried along in the tiny streamlets which form at such times between crop rows, and may even find their way into the smaller creeks. Provided, thus, that the duration of submergence does not reach nine hours, or that the individual receives no fatal buffeting on its journey, it will shortly revive upon becoming stranded, and establish itself anew—perhaps many rods from its place of detachment.

The activity of the red spider during the winter constitutes a two-horned factor, the relative economic status of which is not at once determinable. The fact that the adult mites are not compelled to hibernate bepeaks graphically the hardiness of the species, and holds out little encouragement for the decimation of the pest through the inimical agency of minimum temperatures. On the other hand, the occurrence in the winter of the mites in the active state enables the planter to concentrate his combative efforts at a time when the pest is reduced in number to a minimum. In short, this condition leaves the red spiders in the winter period where they can be easily found and combated by human agencies if so desired. It is a question whether more good or more harm comes, economically, from the attribute of winter activity on the part of the pest.

The non-roving disposition of the red spider is another characteristic which is both to the detriment and the advantage of the farmer, depending on the viewpoint. From the fact that mite individuals usually attain maturity on the identical leaf which harbored them at birth, and are suctorial in nature, it is obvious that spraying operations are complicated to the extent that the applications, to be effective, must be made in such a way as to come in contact with every portion of the infested foliage. This necessarily increases the cost of spraying until the outlay constitutes a considerable proportion of the value of such a comparatively non-valuable crop as cotton. On the other hand, the aversion of the red spiders to moving about has a retarding influence on dispersion and, although it tends to concentrate the attack where present, is decidedly unfavorable to the rapid dissemination of the pest. The aggregate result of the non-roving attribute, coupled with the absence of the power of flight, is that infestation is never continuous over large areas, but is restricted to limited areas with their respective sources as centers. These infested areas appear, figuratively, as countless islands in a sea of immunity. From this, it is easy to see that, to a great extent, every man's problem is actually his own. Hence, if infestation comes from a certain spot on one's premises, proper attention to such a source will yield satisfactory results in spite of the negligence of one's neighbors.

The distribution of the red spider is very general. It has been reported from Maine to Florida, and from South Carolina to Oregon, and it doubtless occurs in every state of the Union. What the original host plant of the common red spider was, seems impossible now to determine. The pest is a very omnivorous creature, having been recorded at Batesburg from 130 hosts. It is most abundant ordinarily upon the English violet, sweet pea, hollyhock, morning-glory, bean, dahlia, tomato and Jerusalem-oakweed. The commonly cultivated English violet seems to serve as the winter host for the vast majority of mites in urban localities. The same mite species has been found also on species of wild violet well removed from domestic habitations. The ubiquitous pokeweed serves as an early seasonal host, but is probably chiefly in the nature of a secondary host rather than that of a normal winter food plant.

The usual time of the first conspicuous appearance of the red spider in cotton fields is about June 30. The pest establishes itself some time previous to this, however, and it is seldom difficult to find migrated females on nascent seedlings in exposed situations. Practically all occurrences in urban localities have been intimately associated with cultivated violet plants and doubtless originated from them. On the other hand, with very few exceptions rural cases of infestation are traceable to pokeweed stalks growing at the field borders or on the terraces.

The description of a particular rural occurrence will serve to illustrate a typical case of origin from pokeweed. In this instance the infestation was seen to grow increasingly severe as one approached a certain point on a terrace. Converging from all directions toward this center, infestation clearly became heavier until an area was reached where the plants were denuded of foliage. Precisely in the center of this area there grew a large pokeweed stalk. It was "alive" with mites and was lightly festooned with their webbing.

It is not yet entirely established whether or not the poke plant functions as a true winter host. The plant is a perennial, and the stalks die to the ground in the late fall. At the base of the dead stalks are to be found the soft, fleshy roots which are very succulent. In addition, at the crown of the roots, at about the ground level, there are always to be found through the winter months the tender dormant buds which give rise to the stalks of the following spring. Upon November 23, following several severe frosts at Batesburg, S. C., a few mites were seen apparently feeding on these winter buds.

In South Carolina there are usually about sixteen generations of red spiders each season. In 1911 there were seventeen, in 1912 there were sixteen and in 1913 there were again sixteen successive broods

of mites as nearly as could be determined. The time required for the development of a generation varies with the prevailing temperature, etc., but ten days is the usual period necessary under summer conditions. It is true that adult females continue to deposit eggs intermittently throughout the winter, and many of these eggs may hatch during the occurrence of mild periods of winter weather but practically no instar development takes places after the middle of October until the advent of vernal conditions. The extent of the mortality arising from adverse winter conditions is largely conjecture. It is very probable that most individuals of the immature stages are killed during the winter, but a very high percentage of the mature mites doubtless survive.

Before becoming established on cotton, one or more preliminary migrations usually occur. In the case of mites overwintering on cultivated violets, they usually become so densely abundant on the host that they cause the plants to wither and die to the ground in early May. This forces a migration which carries the adult females to a large variety of nearby plants—both wild and cultivated. The secondary hosts in turn become overrun by mites and further migrations become necessary. It is these later movements which, as a rule, result in the discovery of cotton by the red spiders, and which most frequently occur during the latter half of May.

The appearance of red spider work on cotton is doubtless familiar to most entomologists of the South, as it also is to many cotton planters. The presence of the pest on cotton is first revealed by the appearance on the upper surface of the leaf of a blood-red spot. As leaves become badly infested they redden over the entire surface, become distorted and drop. The lower leaves usually are first attacked, but infestation spreads upward until often only the bare stalk and one or two terminal leaves remain. Such plants almost invariably die, but at any rate always fail to mature fruit.

It may be said that large fields are probably never completely damaged by this pest, but smaller fields frequently become seriously affected. A thorough examination of all fields within one mile of the center of Leesville, S. C., was made with a view of determining the exact status of red spider infestation at one specific locality. In all, ninety-nine fields were examined as carefully as possible. About 74 per cent of the fields were found to be infested to some degree. This occurrence was perhaps more severe and more general than is usually the case. Probably the most severe case in this locality (a typical case of a very heavy infestation) was one which had its origin in a large clump of badly infested pokeweed stalks which grew at the edge of a barnyard. The pest spread fan-like until it reached in one direction

a point 600 feet from the source. The final affected area, semicircular in shape, comprised thirteen acres, and within its confines the occurrence was general. While such a case as this is unusual, four-acre or five-acre spots with from 25 to 100 per cent damage, are frequently to be seen.

As to the control of this pest, through the operation of natural agencies, there is considerable to be said. As was previously intimated, climatic conditions influence the development of the red spider to a marked extent. During times of little rainfall and high temperature reproduction goes on by leaps and bounds; on the other hand, long, heavy rains work havoc to the red spider population. In spite of the fact that the mites inhabit the underside of the leaves, many are washed off by rains and others are destroyed by the upward bombardment of sand particles which may always be seen coating the lower leaves after storms. In fact, it appears true that a few heavy rains, especially if they continue for some time, reduce, for the time being at least, the degree of infestation to a great extent. As noted before under hydro-locomotion, however, we have demonstrated during the past season that, although a heavy temporary decimation of the pest is occasioned by heavy rains, many of the washed-off adults may be carried considerable distances in the surface water at these times only to revive upon stranding and to establish new colonies remote from the scene of their rearing. Thus rains, which for decades have been accepted unchallenged as an unmitigated blessing to mite-infested crops, are, in the light of this recent discovery, to be held equally responsible for potential powers in quite the opposite direction. The composite effect of these opposed economic rain factors is, doubtless, that of greatly decreasing the percentage of infestation while at the same time considerably extending distribution.

The effect of freezing weather has been previously touched upon. From observations made during the winter, it is doubtless true that most of the mites in the young stages are killed by the minimum temperatures. This naturally prevents any considerable winter increase, and, in addition, a very small percentage of adults may also perish. It must be borne in mind, however, that the red spider is remarkably adapted to withstand low temperatures. To illustrate this point it is interesting to record an observation made at Washington, D. C., during the severe winter of 1911–1912. Adult red spiders collected on a morning following a night temperature of $-13°$ F. were brought into the indoor atmosphere whereupon the majority of them rapidly revived.

In the case of each of the seasons 1911, 1912 and 1913, during which the red spider has been under observation at Batesburg, a sudden

decimation of a more or less complete nature has occurred within the ranks of the pest. During the seasons of 1911 and 1912 the main decimation occurred mainly in the last two weeks of August. In the case of the past season, the decimation occurred during the early days of July, or nearly six weeks in advance of the case of the two previous years. The phenomenon, indeed, happens suddenly, and the agencies which work to produce it are unquestionably of great economic importance. The ageing and toughening of the leaves at about this time may cause some mites to desert cotton for other plants, but the factor of real importance is the abundance of several species of insect enemies which gain dominance at just this time. Following are the beneficial species of particular economic importance which have been observed at Batesburg during the last three seasons.

Careful observations have convinced us that the larva of a small Itonid fly occupies first rank among the enemies of the red spider. The species—*Arthrocnodax carolina*—was very recently described by Doctor Felt from material sent to him from Batesburg. This predator appears to confine its attack entirely to the eggs of the red spider. It usually becomes noticeable first about the middle of June and multiplies rapidly until toward the end of July, when the species becomes so superabundant that its checking effect on red spider infestation is most conspicuous. Too much emphasis cannot be placed on the economic value of this species, and to its activitiy is probably largely due the seasonal decimation of the red spider. It has been collected from Virginia, North Carolina, South Carolina, Georgia, Florida and Alabama and has, evidently, a wide distribution. It is interesting to note that this predator becomes heavily parasitized later in the season by a minute Chalcidid fly which has been identified by Crawford as *Aphanogmus floridanus*.

The insidious bug, *Triphleps insidiosus*, of the family *Anthocoridae*, probably ranks second to *Arthrocnodax* as a predator upon the cotton mite. It appears somewhat earlier in the season than the latter, being seen occasionally as early as the middle of May. Both the nymph and the adult stages prey upon the red spider, the former feeding chiefly upon the mite eggs, while the latter attacks adults and immature stages.

The small, dark Coccinellid species—*Stethorus punctum*—was very abundant through July, and in the case of some badly mite-infested jump-vine leaves, it was responsible, almost unassisted, for the extermination of the pest. This species ranks close to *Triphleps* as a mite predator.

A species of lace-winged fly, *Chrysopa oculata*, probably ranks next in order among the enemies of the red spider. They become plentiful

ordinarily, about June 15, and the larva are active among cotton mite colonies. During September a large series of Chrysopa cocoons were bred in the laboratory, and it is interesting to note that at least seven species of parasites occurred so plentifully that over 48 per cent of the Chrysopids were attacked.

During the month of July a species of thrips was observed to be actively predaceous upon the red spiders. This species has been identified as *Scolothrips sexmaculata* by Mr. Morgan. It was exceedingly abundant on infested cotton at Leesville, S. C., on July 25, of the present year, and practically controlled some belated occurrences of the pest in several observed fields.

In addition to these five principal predators, there might be mentioned a Syrphid larva, several species of lady-beetles, and one or two other thrips species which have been seen occasionally in or about red spider colonies. It has not yet been determined whether there are any internal insect parasites of the cotton mite.

An extremely interesting association of "cause and effect" seems to have been established governing the fundamental origin of the great fluctuation in degree of infestation occurring from year to year. The winter of 1911–1912 was the severest in South Carolina for many years. Hence it might be expected that the following season would be a mild one, from the standpoint of injury by the red spider, through the assumed heavy mortality of the pest during the winter. On the contrary, as has been stated before, the 1912 occurrence was the severest on record. The only possible explanation appears to embrace two suppositions. One is that the adult red spider is little susceptible to extreme cold. The other is that the insect enemies of the mites succumb much more readily to minimum temperatures than do the mites themselves. Both of these hypotheses are sustained by all of our observations. Naturally, then, a severe winter is precisely what would most favor the subsequent increase of the red spider through the destruction of its insect enemies. Conversely, an abnormally mild winter, free from decidedly low temperatures, would furnish conditions most favorable for the survival of the repressive species, and the infestation for the following season would be mild. Thus, if this rule is unerring, it becomes obvious that the influence exerted indirectly upon the red spiders by pre-seasonal conditions is potentially greater than that of other factors operating during the active season.

Remedial Measures

Prevention

From the abundant experience of the last three years we have been forced to the conclusion that the eradication of the red spider must be

accomplished through preventive efforts rather than repressive ... is to be economically effected. In the case of certain of our ... crop pests there exists at some stage in their life-cycles a condition ... habit which constitutes a vulnerable point of attack. At such ... of assailability the agriculturist is enabled to execute control measures both with comparative ease and dispatch. In the case of the ... spider, however, no such vulnerable stage occurs. One generation rapidly follows the other with monotonous regularity and homogeneity. The stages are alike in structure and behavior, the eggs ... impervious to the action of sprays, and the feeding habits ... identical from the time of hatching till death. The location of the mites through the winter and spring, their preference for the cultivated violet and the pokeweed, and the manner of dispersion of the pest, however, lead to the presentation of the following cultural expedients.

Clean culture.—First among preventive measures against the ... spider is doubtless that of exterminating the weeds and plants which breed the pest. Pokeweed, Jerusalem-oakweed, Jamestown weed, wild blackberry, and all border weeds and underbrush about ... should be burned or grubbed out during the winter or early spring and should be kept down throughout the summer as far as possible. This plan has been tested in several instances and has given complete immunity the following season. Too much emphasis can not be placed on the importance of destroying, so far as possible, all ... growth—especially the pokeweed, which should be grubbed out ... the roots.

Control on violets.—As before stated, most cases of infestation ... urban localities have their origin in borders of cultivated violets growing in nearby house yards. In several instances violets adjoining fields of past severe annual infestation have been thoroughly sprayed with the result that no red spiders appeared subsequently in these fields. The objection to this treatment is the failure on the part of the average person to persevere with the spraying until the mites have been entirely exterminated. The most satisfactory procedure in such cases consists in the removal and destruction of the offending violets.

Varietal immunity in cotton.—From several tests conducted in different fields with numerous standard varieties of cotton, and ... the information volunteered by farmers from many portions of South Carolina, data have been accumulated which clearly indicate that certain varieties are susceptible to red spider infestation, while others exhibit considerable immunity. Careful observations on a considerable number of varieties grown for the purpose showed the ...

"Wilt Proof," Toole, Peterkin, Broadwell, and Cook suffer most (in the order named) from the attack of the pest, while Hite, Russell, Summerour "Half and Half," and Cleveland showed the greatest immunity of all the varieties investigated. Further investigation of this feature of the problem will doubtless throw additional light on the relative desirability of the common cotton varieties from the viewpoint of immunity.

Spacing.—It has been claimed by one investigator, who held that intrafield dispersion occurred only directly from branch to branch, that wide spacing of the stalks, by preventing the interlacing of the branches, would prevent the spread of the red spider through a field. Experiments at Batesburg have shown that the red spider commonly travels between plants upon the ground. Thus, although dispersion might be slightly impeded through the adoption of wide spacing, the futility of this measure becomes evident in view of the regular occurrence of terrestrial travel.

Time of planting.—There is yet much doubt as to the relative advantages of early and late planting. Extremely early planting naturally permits the plants to develop a maximum growth of weed and fruit by the time of serious mite appearance. It is noticeable that plants of considerable size are rarely killed by the pest, nor are well-advanced bolls commonly shed from infestation. On the other hand, several fields about Leesville, S. C., which were planted as late as June 20, seem to have largely escaped the infestation which was so general at that locality. Late planting, however, is almost universally objectionable to the farmer, since in ordinary seasons it results in a reduction of the yield.

Rotation.—In an effort to test the rotational value of other crops, numerous field crops have been planted in or near infested areas. In addition, frequent examinations have been made of a great many garden and vegetable crops in infested localities. Besides cotton, red spiders are known to occur not at all uncommonly upon the following field crops: Cowpeas, clover, corn, hops, and watermelon. They are also found frequently on the following garden crops: Peas, beans, onion, tomato, lettuce, okra, turnip, mustard, squash, beet, sweet potato, and strawberry. A really acute infestation on corn was seen at the height of the 1912 season. Cowpeas are particularly attractive to the pest, and sweet potatoes have been noted to be badly infested. Should an immune crop be found and employed, it is extremely probable that the pest would reinvade the fields upon the return to cotton culture with as great ease and quickness as it has done during any previous season, providing the sources of infestation were at hand. Rotation, then, does not promise to contribute toward the solution of the problem.

Effects of fertilizers.—A rather elaborate series of tests with fe[illegible] has been conducted in an attempt to determine whether the [illegible] applications assisted cotton to withstand the injurious effects of i[illegible]tion. The result of these experiments have been negative and [illegible] been impossible to deduce any definite conclusions.

Repression

We have just discussed cultural measures which may help to [illegible] infestation. We will now consider what may be done to comb[illegible] pest when it has already gained entrance to a field.

As before intimated, we believe in the efficacy of prevention rather than cure, in the case of the red spider. When once well established in a cotton field the pest is a difficult one to wipe out. That it is possible, however, to eradicate the pest from infested fields has been demonstrated beyond doubt, but in many cases the task is so tedious that only the most determined farmers will undergo the effort necessary to accomplish the extermination.

Removal of infested plants.—The experiment has been thoroughly tested of pulling up and destroying the first few plants which show infestation. In such cases the operation must be repeated several times. Great care should be observed in locating every plant which shows the characteristic red spots, and these must be carefully taken from the field and burned. If infestation has not advanced far, this treatment is usually effective, and a red spider invasion often may be thus "nipped in the bud" and entirely eradicated.

Occasional observation of instances wherein infestation had abruptly stopped at a much-traveled road suggested the idea of plowing a wide swath just outside the boundary of infestation. This was attempted in one case where the infestation had covered about two acres. A [illegible]-foot ring was plowed around the spot, and all stalks, both in the swath and in the inclosed area, were immediately burned. Unfortunately the farmer did not make sure that he was beyond the outermost zone of infestation, and, consequently, a sufficient number of affected plants remained outside the pulverized barrier to continue, somewhat, the dispersion of the pest. This idea should be given further test [illegible] seems there should be great efficacy in the operation, provided the swath is kept stirred frequently.

Insecticides.—In the course of the investigations on the cot[illegible] [illegible] almost two score of spray combinations have been thorough[illegible] [illegible] under conditions entirely natural. Since no substance was di[illegible] [illegible] which could be safely used to destroy all eggs in one appli[illegible] [illegible] has been found necessary to spray twice, with an interval [illegible] [illegible] seven days, so as to destroy the hatching larvæ. The killi[illegible] [illegible] of all these sprays was computed, and the percentages ran[illegible]

100 to 0. The large majority of the compositions proved to be entirely ineffective against the red spider. A few proved to be deadly to the mites but were eliminated owing to the fact that they were injurious to the foliage. About eight sprays in all have weathered this process of elimination and can be recommended with confidence as efficient acaricides. These effective sprays are: (1) Potassium sulphid (3 lbs. to 100 gals.), (2) home-made lime-sulphur solution, (3) kerosene emulsion, (4) resin-wash, (5 and 6) miscible oil (uncombined and combined with "Black Leaf" tobacco extract), (7) "Sulfocide," and (8) flour-paste solution (diluted 1 to 8). From a rather extended use of these compositions it seems established that if one of these were to be used in preference to all others, it would probably be potassium sulphid. This insecticide commends itself from every standpoint cheapness, simplicity of preparation, ability to kill quickly, and safety of foliage. Altogether it seems to be an ideal red-spider spray. It was found that 100 gallons, when applied as a misty spray, about sufficed to treat an acre of average-sized cotton at a cost of about 75 cents for the material.

Spraying outfits.—The sort of outfit to be used for red-spider spraying depends mainly upon the extent of the occurrence. Some have sprayed their score or so of affected plants with a 75-cent tin atomizer. While this instrument is very economical of liquid and throws a misty spray which penetrates and blows to all parts, it is not economical of time. The bucket pump and knapsack pump come into use in cases of considerable scattered infestation or for the treatment of a few high plants. The most economic outfit for a severe case involving several acres consists of a barrel pump carried through the field on a wagon. One man drives, one pumps, and one handles each sprayer (of which preferably there should be two). Thorough treatment of three or four acres per day is readily obtainable with this device. For safe work, however, this outfit should be used only on cotton of average or low size, as the passing wagon will injure large plants.

Necessity for thorough spraying.—Some dissatisfaction has been experienced among certain of those who have undertaken to check the ravages of the red spider by spraying. This can be understood on account of the extreme care which must be exercised in order to secure effective results. In the case of insects which devour the plant tissue, even the careless application of Paris green or lead arsenate to the top of the foliage is often effective. This is explained by the fact that such insects are constantly moving from leaf to leaf and will eventually eat some of the poisoned tissue. Moreover, these insects often eat entirely through the leaf, and hence it matters little whether the poison falls on one side or the other. With the red spider, however, it is

altogether different. A contact insecticide is absolutely necessary, and from the fact that the mite as a rule passes its entire existence on the under side of a single leaf, it becomes plainly necessary in spraying to *hit the entire underside of every leaf* of an infested plant. It is obvious, therefore, that indifferent spraying is certain to yield unsatisfactory results. Furthermore, the absolute necessity for a second spraying to kill the hatched eggs adds to the difficulty. It is hoped that the discussion may clearly convey *the economy of prevention* of infestation.

In conclusion we will refrain, in this brief consideration, from an orderly summary or reiteration of the salient points herein contained. It should be emphasized once more, however, that the red spider, as a pest, presents phenomena of a biologic and economic nature which are rather unique. The winter activity of the pest, the rapid succession of many overlapping broods, the lack of flight, the extreme omnivorous and ubiquitous character, the limitation of dispersion chiefly to travel afoot and by water, the almost impervious protective web, the spray-proof character of the eggs, the restriction of infestation to the bottom of the leaves, the non-wandering nature of the individuals of the colonies, and, finally, the microscopic size of the creatures all are characteristics which individually and collectively complicate the problem of control. A serious consideration of these factors cannot but impress one with the intricacy of the red spider's status within its environment.

THE GREEN SOLDIER BUG (NEZARA HILARIS)

By R. D. Whitmarsh, *Ohio Agricultural Experiment Station*

Occurrence and extent of damage. During 1911, peach growers along the Marblehead peninsula region of Lake Erie sustained a severe loss as the result of injuries caused by this insect. Although it has been commonly found in Ohio for many years, it had never been reported in any such abnormal numbers before, and so far as I am able to find out was never reported as a special enemy of the peach in this state. I understand *Nezara hilaris*, or more probably a closely related species, *Nezara viridula*, has at times done considerable damage to peaches in Georgia and oranges in Florida.

But little was accomplished during 1911 in determining [illegible] history of this insect, as we were not informed of the severity [illegible] attack until the first of September. On visiting the infested [illegible] the conditions were found to be fully as bad as one of the gro[illegible] peaches in that region had proclaimed them to be. He estim[illegible] loss at fully $500 and others professed similar losses. No on[illegible]

the quantities of worthless, gnarled fruit lying on the ground could support their statements in the least. Many of the Elberta trees showed a loss of two, three, or more bushels per tree.

CHARACTER OF INJURY. These bugs commence feeding on the small fruit during the last part of June and in early July, and continue working upon the fruit until late fall. They feed by puncturing the skin with the beak, and by sucking the juice from the flesh of the fruit. In a short time, a small droplet of gum appears at the injured point, which in time becomes irregular in outline, owing to the fact that the cells about the puncture are killed, thus making them incapable of further growth. The degree of irregularity, of course, depends upon the number of punctures. Where the fruit is badly punctured, it becomes entirely unsalable, while extra fine fruit showing but one or two punctures has to be graded lower, thus decreasing its value.

INJURY OF 1912, AND NOTE ON LIFE HISTORY. Practically no damage was done during the year, and so far as I was able to find out from the growers and by making a visit to the previously infested district, hardly a bug was seen. One egg-mass, however, was found of this species, while collecting at Wooster, on a leaf of *Viburnum prunifolium* (black-haw) the last week in June, which hatched on July 1. From this egg-cluster I was enabled to carry two specimens, a male and female, through five instars to the adult stage, which was reached on September 1 and 2.

NOTES FOR 1913, AND A FURTHER ACCOUNT OF THE LIFE HISTORY. The past season, these bugs were reported as occurring in small numbers on peaches in the previously infested district along Lake Erie, but the damage done was but slight compared to that of 1911. While collecting in and about Wooster, I found them particularly abundant on wild cherry in the latter part of June, and afterwards on elderberry, black-haw and dogwood (*Cornus alternifolia*), thereby enabling me to work out the life history in detail, both in the field and laboratory. The first appearance of the adult form, after hibernating through the winter in protected places under leaves and loose earth, was about the middle of June. The time of appearance is undoubtedly controlled by the season, probably occurring a little later than usual the past year, as it was comparatively backward. I found five adults on June 11, on wild cherry, and after that date found them in abundance up until the latter part of June, when the number of adults seemed to decrease until one could hardly find a specimen after the middle of July. The decrease in adults was marked by a corresponding increase in the number of immature bugs.

The eggs laid by different females sometimes vary in color; commonly she desposits light, yellow-colored eggs, but occasionally will

deposit light-green eggs. This is an individual characteristic, the cause of which is unknown. The color of the eggs remains constant in each successive laying by the same female. From two to three days before hatching, both the yellow and green-colored eggs take on a pinkish shade which increases in depth until the cap-end becomes nearly red, just before hatching. The number of eggs laid by different individuals varies; one insect may deposit three clusters of eggs. The first laying is always the largest, usually consisting of between 40 and 50 eggs, although some individuals do not deposit nearly so many. The second laying of eggs contains commonly about half the number in the first, although this sometimes varies. The third cluster, when there is one, commonly contains from two to six eggs. They adhere to each other by a cement-like secretion deposited by the parent and are attached to the leaf by a similar substance. They are oval-shaped, and are largest at the top, or cap-end. They measure about one-sixteenth of an inch high, by one thirty-second of an inch across. On looking closely, one will see a small circular cap, around which is a single row of rather stubby, clubshaped, spine-like processes. The eggs hatch in from seven to nine days. The period from the egg to the adult varies. The shortest period from the time of hatching of the egg to the adult stage, recorded during this season's experiments, was from July 23 to September 10, or a total of forty-nine days, the cluster of eggs having been laid on July 14. The longest period, which, by the way, was from this same egg cluster, was from July 23 to October 6, or a total of seventy-five days. The following is a record of the life history of the young bugs hatched from the above egg-mass. Eggs hatched July 23 during the forenoon, and the young nymphs remained in a mass beside the egg shells from which they hatched, without feeding, until 4.15 p. m., July 28, when they commenced molting. After having molted, they separated and started feeding on the berries continuing to feed and resting at intervals until some time between 4.30 p. m., August 6, and 7.30 a. m., August 7, when most of them molted. The final specimen did not, however, molt the second time until August 8. August 13 two specimens molted the third time, carrying them into the fourth instar. They continued molting at intervals until sometime between 4.30 p. m., August 17, and 7.30 a. m., August 18, when the last two molted the fourth time and [illegible] time on specimens molted at intervals until they had all molted the fourth time on September 2. On September 10, two specimens molted the fifth time, becoming adults, and the molting continued [illegible] the last specimen transformed some time between 4.30 p. m., O[illegible] and 7.30 a. m., October 6. This was, by the way, the lat[illegible] record which I have for the maturing of this species in captivity.

After becoming adults, they continue to feed until cold weather, when they conceal themselves in some protected place, coming up on warm days, but returning to their hibernating quarters with each cold spell, and after real winter weather sets in, do not appear again in any noticeable numbers until the warm weather of the following year. The 11th of June was the first day of the past season on which I found any specimens. The scarcity of bugs up to this time, as I have previously mentioned, was undoubtedly due to the backward spring, as we did not have any real warm weather until the first of June. After this I had no trouble in finding the bugs. The latest date recorded for taking the adults, while collecting, is November 6; however, I did find one specimen resting on the wood-work in a breeding cage out of doors December 4; but I believe that most of the bugs seek sheltered places soon after the middle of October, as it is very hard to find any after that time.

Conical Grape Gall (*Cecidomyia viticola* O. S.). The characteristic gall produced by this species is reddish or reddish green, one-quarter to a third of an inch long and occurs on the upper surface, sometimes in numbers, of the leaves of various species of grape. It is not common though occasionally locally abundant. The larva, though minute and difficult to discover in the gall, is an exceedingly interesting form, since the appendages at the posterior extremity are evidently used as prehensile organs, as was demonstrated by observation upon living specimens last summer. The interior of the gall is so smooth that there would seem to be little or no opportunity for the larva to use this grasping power while in the deformity it produces, though it is possible that its ability in this direction may be extremely serviceable after the maggot enters the soil, which latter is presumably the case.

Larva. Length 1 mm., moderately stout, pale yellowish green. Head broad, broadly rounded anteriorly, almost subglobose. Antennae moderately long, stout, biarticulate, the basal segment disk-like, the apical one with a length over twice its diameter. Conspicuous brownish, presumably ocular spots may be observed near the latero-posterior angles of the head. Skin smooth, segmentation distinct; breast-bone weakly chitinized, minute, reniform, the anterior margin with two small submedian teeth and more laterally a pair of smaller teeth; small scattering setae occur on the body; posterior extremity bilobed, the ventral portion bearing stout, submedian, chitinous, upcurved processes, each with an indistinct basal tooth anteriorly; the dorsal lobe broad, obliquely truncate as seen from the side and the face armed with an irregular series of moderately large, conical, chitinous teeth.

In life the hooks and this dorsal process are frequently apposed and evidently form an efficient grasping organ. The description was drafted from larvae taken from the galls, the tips of which were turning brown, collected at Highland, N. Y., July 22, 1913. There were about seventy-five galls on one leaf.

E. P. Felt.

A DESTRUCTIVE PINE-MOTH INTRODUCED FROM EUROPE

(*Evetria buoliana* Schiffermiller)

By August Busck, *of Branch of Forest Insects, Bureau of Entomology, United States Department of Agriculture*

In May, this year, a correspondent from Long Island reported to the Division of Forest Insects of the United States Bureau of Entomology, that a Lepidopterous insect was seriously injuring some young Scotch pines (*Pinus sylvestris*), under his surveillance at Great Neck. Specimens of the larvæ and the injury were referred to the writer for identification.

The severity of the injury was at once realized, but the larva could not be identified. In order to ascertain the extent of the injury and to obtain sufficient live material for study and rearing, the writer was authorized to visit the locality and this was done on June 1. It was found that the trees had been planted on both sides of avenues, in a large, newly developed suburban tract, and that all of these trees were heavily infested by a Lepidopterous larva, which tunnelled the tips of the leading branches and thereby severely checked the growth and injured the appearance of the trees. On some of the young trees, eight to ten feet high, as many as fifty terminal shoots had been destroyed and their usefulness as ornamental trees was much impaired.

At this time many of the larvæ had pupated and from the material secured a large number of the moths issued during the last half of June at the field station for forest insects, East Falls Church, Va. It proved to be the well-known European *Evetria buoliana* Schiffermiller, which has hitherto not been reported from this country.

This species, which also occurs in Siberia, does considerable damage to the pines of Europe, and it has been the object of much study and an extensive literature. It is generally recognized by leading foresters in Europe as one of the most or even the one most injurious insect to *Pinus sylvestris* and other pines. A characteristic [illegible] of the injury of this insect is a peculiar curved growth, the so-[illegible] "Posthörner," "Baionnette," which is a familiar sight in Eu[illegible] pine forests, and which seriously depreciates the value of the t[illegible]

The occurrence of this insect on Long Island is, therefore, [illegible] importance; our several indigenous *Evetria* species already con[illegible] a serious problem, especially in the culture of young pine tre[illegible] this European importation may well outrank our native sp[illegible] destructiveness. However, it is futile to speculate about the [illegible] spread of the species to our native pines and the resulting [illegible] but it is, at least, a just cause for apprehension and it should [illegible]

fully watched in view of the experience with other forest *Lepidoptera* introduced accidentally from Europe.

How long the species has existed in this country and how extensive is its present range must be determined by investigation. It was observed on the pines at Great Neck last season also, 1913, and Dr. Hopkins was informed about it, but too late to secure material.

However, it seems probable that it is a recent introduction, considering that the species has not been noticed before, although special work on this group of pine insects has been done by Packard, Riley, Fernald and later workers, and extensive and careful collecting has been done in recent years on Long Island by the several active entomologists of the vicinity, and the more so, as it is a strikingly colored, orange-red insect, three fourths of an inch or more in alar expanse, larger and quite different from the other species of the genus. The work also is easily noticeable and presumably would have been observed before, if the species had been present.

The eggs are laid on the buds of pine in the late summer; the young larva eats out one bud during the fall and overwinters within; in the spring it leaves this bud and attacks the young growing buds, excavating and successfully killing a number of these; as the twigs grow, the larva often eats only one side of them, thereby causing the above-mentioned curved growth, which results in the characteristic "Posthorn." The larva is dark brown with black head and thoracic shield, it becomes mature early in June and pupates within the last silk-lined burrow; the moth is 17–22 mm. in alar expanse; the forewings are ferruginous orange, suffused with dark red, especially toward apex, and with several irregular, anastomosing, silvery cross-lines and costal strigulæ.

The species has only one generation in Europe, overwintering as half-grown larvæ and issuing as moths in July, but allied species of the genus in this country have two generations annually, and it is not impossible that *Evetria buoliana* may also develop two broods in this climate and thus greatly increase the potentiality for injury.

Entomologists and others interested are asked to be on the lookout for this destructive insect and to please report eventual outbreaks to Dr. A. D. Hopkins, in charge of Forest Insect Investigations, Bureau of Entomology, United States Department of Agriculture.

EXPLANATION OF PLATE

Fig. 1. "Posthorn" growth caused by *Evetria buoliana.*
" 2. *Evetria buoliana* 2½ times enlarged.
" 3. *Evetria buoliana* young larva in pine buds.

1, after G. Severin: "*Le genre Retinia.*"
2 and 3, after J. E. V. Boas: "*Dansk Forstzoologi.*"

Proceedings of the Twelfth Annual Meeting of the American Association of Horticultural Inspectors

(Continued)

REPORT OF COMMITTEE ON STANDARDIZATION OF PHRASEOLOGY AND VALUE OF INSPECTION CERTIFICATES

The undersigned committee begs to submit the following report:

It has long been recognized among state inspection officials that there is a diver- sity of wording, meaning and value of inspection certificates which is not only confusing and misleading but which conflicts with the general purposes of the inspector's work. In dealing with the subject assigned to this committee we must first of all clearly recognize the objects in view in state nursery inspections. These we believe is, beyond dispute, the restriction of the spread, the prevention of unnecessary dissemination, and the extermination, whenever practicable of insect pests and plant diseases within the state maintaining the inspection service. In the prevention of unnecessary dissemination three lines for the accomplishment of good results are open. First, the management of local problems which are not of direct concern to other states; second, the prevention of nursery stock grown in the state being transported in interstate commerce in an infected or infested condition; third, the inspection of every living tree or plant imported into the state from another state. The last line of activity is not available to all state inspection officials at present. The second line is of immense importance to all states even those fortunate enough to have provisions for the inspection of all imported trees and plants at destination. In order to receive the full benefits of efforts to prevent diseased and insect infested nursery stock being transported interstate, each inspection official must recognize this object as a purpose, in part, of nursery inspection work in his own state. The issuance of general nursery certificates or licenses with the knowledge that they will be or may be used as a required accom- paniment of interstate shipments of nursery stock, is in itself a virtual rec[...] of this principle. A clear understanding by all concerned, of the phrase[...] of the value of inspection certificates, will, we believe, lead indirect[...] improvement to a considerable extent in the condition of interstate ship[...] nursery stock.

In acquiring information for the preparation of this report, a circula[...] tions was sent out to the head inspection official in each state and forty f[...] were received. The thanks of the committee are due these men for the [...] mation and for many valuable suggestions which they have submitted.

Thirty-four state inspection officials report that they either have ful[...] to change the present wording of their state certificates or that it ca[...] without amendment of the existing law. Six only report legal limitat[...] consequence.

Eighteen are in favor of retaining their present form of certificate[...] something better can be decided upon; sixteen are unqualifiedly in favo[...] ing the present wording; five are unqualifiedly opposed to retaining [...] wording of their state certificates; three favor their present form wi[...]

s... changes; one would "compromise for the sake of uniformity" although satisfied with his state certificate as at present used. Of the forty three answering, twenty-four may be considered to have indicated a willingness to change the wording of their certificates to conform to any improvement which may be decided upon by this association, while nineteen may be considered not to have indicated such a willingness.

Twenty-five, or nearly 60 per cent of those answering the question, consider that their respective state certificates are literally accurate, twelve, or nearly 30 per cent, consider that their state certificates have a literal meaning but with miscellaneous mental reservations and qualifications, six do not consider their certificates to be accurately worded.

Thirty six believe it practicable to secure uniformity to a reasonable degree at least of the wording of certificates, three regard the accomplishment of this as doubtful, two regard it as impracticable and one expresses the conviction that uniformity of wording is unnecessary, that uniformity of *meaning* is all that should be desired. Of the thirty-six who replied in the affirmative, six expressed the following qualifications: (1) "If insects or diseases found were named in the certificate;" (2) "If every tree is inspected root and branch at the nursery;" (3) "By fumigating all stock not absolutely clean;" (4) "In simplified form;" (5) "Very liberal in form not too explicit;" (6) "One for the North and one for the South."

As far as can be determined, the inspection certificates of all states cover both insect pests and plant diseases except that in three cases "fungus" diseases only are specified in the certificates, omitting from consideration bacterial diseases, root knot and plant diseases due to unknown causes.

Thirty-five species of insect pests and twelve plant diseases necessitated the temporary withholding of inspection certificates in various states during the past year. Of these pests and diseases the San José scale is reported as the cause of the action named in 27 states, crown gall in 15 states, the oyster shell scale in 10, the woolly apple aphis in 9, pear blight in 7 states, the scurfy scale in 5 states, the peach borer in 5 states, and all of the other pests and diseases in less than 5 states each. In the foregoing enumeration several states have been included more than once.

Of 41 states answering the question concerning the matter, 34, or nearly 85 per cent, have only one form of certificate which is used on stock which is grown in nurseries where no pests whatever are found and also in nurseries where pests were found, but subsequently apparently exterminated. Of these 34, six provide for the inspection of the stock at the nursery at the time it is dug and under such a provision the certificate has an entirely different meaning and value. One state reports one form of certificate with a few special exceptions, and six report different kinds of certificates adapted to the circumstances. Florida has five types of certificates. In addition to the ordinary blanket certificate and special package certificates, a local sales certificate is used. This is issued to nurseries having stock diseased or infested by pests in any degree and located in sections where those particular diseases or pests are prevalent. They are plainly indicated as void for rail or water shipments. Kansas and New Hampshire issue two kinds of certificates, one the ordinary blanket form and one a certificate of fumigation. Ohio also uses these two forms but, in addition, has strict requirements concerning the disposition of the stock fumigated for the San José scale, not permitting it to be sold in the state except in infested sections and with the knowledge of the purchaser. In Louisiana certificates are issued which are limited to use for certain

plants only. In West Virginia two forms of certificates are issued cover... classes of nurseries, one where no "dangerously injurious insects or pla... cases" are found, and one where such have been found and subsequently ex... minated.

Of 43 states furnishing the information 26 have no established list of ... pests to which their certificates have special application. Seventeen stat... a regular list. The inclusion in the state law of such phrases as "San Jos... and other injurious insect pests or plant diseases" is not here regarded as ... established list. Of the established lists the most comprehensive is that of C... necticut which includes 20 insect pests and 10 plant diseases, closely follow... Utah with 17 insect pests and 11 plant diseases. In many cases the list is ... or less elastic, but in several states, even with comparatively limited lists, ... pests and plant diseases not officially designated as "dangerous" are disrega... In the case of two adjoining states having practically identical insect pest ... plant disease problems, one disregards all except 11 insects and 7 plant diseases, total 18, while the other practically disregards all except six insects and three pl... diseases, total 9. In another instance all except 16 insect pests and plant diseases are disregarded while in an adjoining state all except 10 are disregarded.

With reference to the insects which are regarded as "dangerous" pests ... reports from several states inform us that certain economic insects, such as the oyster shell and scurfy scales are regarded as coming within the meaning ... the state law or certificate only when they are doing actual damage to the nurse... trees where found. This practice may be objected to on the ground that a ... infested tree is more likely to be noticed by the average purchaser or even ... out by the nurseryman himself, whereas the slight infestations are more apt to be overlooked and are therefore more likely to be the cause of transferring ins... pests to previously uninfested orchards or localities.

Reporting on crown gall, which disease was taken as an example to deter... the difference in values and meanings of certificates, 37 inspection officials req... the destruction of infected stock or at least do not permit its sale. Of the... six provide inspectors to examine the stock when dug and to see that the ... ment is met, three require a written pledge from the nurseryman that infe... stock will be separated out and destroyed and 28 apparently have no ... arrangements concerning the matter. Aside from the 37 who report *requi...* two report that the nurserymen are "requested" to separate out and ... the infected stock, two report no requirements and two are fortunate in not ... met with the disease in their respective states.

Answering a question as to whether it would be practicable to file annual... every other state inspection official, a list of nurseries to which certifica... been issued, thirty-seven states report in the affirmative, one can furnis... bonded and licensed nurserymen, two report lack of provisions for the ex... work and for postage and two report that no general certificates are issue... two could no doubt furnish lists of bonded or licensed nurserymen.

One question related to the practicability of each state inspection ... charge furnishing each other chief state official with a detailed report of ... findings of the inspectors in each nursery. Thirty-three, or more than 75 ... gave not unfavorable replies, including 31 affirmative replies without qual... Two considered the matter doubtful. Six, including one on account of ... funds, reported unfavorably, while two could not coöperate since no gene... cates were issued.

The examination of the general inspection certificates of 30 states ...

able variation in the phraseology concerning the pests and diseases. Nine ...fically mention the San José scale. The general terms used are as follows:

> "dangerously injurious insect pests and plant diseases," 11 states; "injurious insects and plant diseases," 4 states; "insects and diseases of a seriously dangerous nature," 2 states; "any contagious or infectious disease or the San José scale or other dangerously injurious insect," 2 states; "dangerous insects or plant diseases," 1 state; "insect pests and fungus diseases," 1 state; "destructively injurious insect and fungus enemies," 1 state; "destructively injurious pests," 1 state; "dangerous insects and dangerously contagious tree and plant diseases," 1 state; "dangerously injurious insects and contagious plant diseases," 1 state; "disease, scale or other dangerously injurious insects," 1 state; "dangerously injurious pests or fungus diseases," 1 state; "dangerously injurious insect pests or dangerously destructive plant diseases," 1 state; "dangerous insect pests and dangerously contagious tree or plant diseases," 1 state and finally "noxious or injurious diseases likely to be transmitted on nursery stock," 1 state.

It appears evident that these variously phrased certificates are all intended to ... about the same meaning and that they do in fact have identical meaning to the general public. The advertising values to the nurseryman are the same even though a scientific man may recognize the fact that "crown gall" and pear blight are not included as "fungus" diseases and that a certificate regarding crown gall issued without an examination of the roots is valueless. It has been shown by the replies which have been classified in this report that the general designation "dangerously injurious insect pests and plant diseases" or the equivalent can be interpreted only by one who knows which, if any, pests are listed and which disregarded in the states maintaining an established list, and in the other states which pests are personally regarded as dangerously destructive by the official in charge. The reports from many if not most states, plainly indicate that the interpretation to be given to the certificate phraseology applies strictly within the limits of the home state.

Certain variations from the ordinary systems of certification have been mentioned. Other noteworthy variations are the systems in Arkansas, Illinois and Wisconsin. The first two states issue certificates which are given more than ordinary value by a system of signed agreements relating to the treatment or the elimination of stock infested or infected with woolly apple aphis, crown gall, peach borer and other common pests found in the nursery in nearly all sections of the country. Following a report on the condition of the nursery and specifications as to required treatments, the Illinois system requires the nurseryman to sign the following agreement as a condition of the issuance of the certificates.

> "I, ——————— hereby promise and agree that the above mentioned conditions shall be observed as affecting any and all nursery stock grown or growing on ... premises; and I also agree that I will not use, or permit to be used, any other certificate of nursery inspection issued to me by the Illinois State Entomologist on any of the stock to which the above prescriptions and requirements apply until said prescriptions and requirements have been fully complied with."
>
> Signature ———————.
>
> Date ———————.

The Wisconsin system is one of permits rather than of ordinary inspection certification. No declaration is made as to the apparent freedom of the stock from pests, but we believe no one can question that such permits mean fully as

much as those which are specific and comprehensive in their declaratio[illegible] furthermore, are above criticism on the charge of misrepresentation in any [illegible]

The following noteworthy suggestions have been received by the comm[illegible] connection with the question sheets sent out for information:

Mr. H. M. Williamson, secretary of the State Board of Horticulture of [illegible] recommends as a solution of the problems concerning interstate shipm[illegible] plants, that all such shipments should be inspected by agents of the [illegible] Government. Dr. E. W. Berger of Florida suggests that the Federal Horti[illegible] Board be given power to regulate interstate shipments of plants, especiall[illegible] the view to providing for complete information concerning the pests found [illegible] nursery making interstate shipments, such information to be placed in the [illegible] of the inspection official in charge in each state. Professor Summers of [illegible] and Professor O'Kane of New Hampshire express the sentiment that the [illegible] of uniformity of wording is of comparative little importance, that it is the sta[illegible] ardization of meaning and of value which is needed. Professor Sanders of W[illegible] consin recommends the license system used in his state as of value incide[illegible] in eliminating dishonest dealers and he recommends the plan of includin[illegible] acreage in each case as a part of the license, stating that this prevent[illegible] misrepresentation. The inspection officials of Montana, Idaho, Marylan[illegible] Arizona endorse the plan of inspecting everything at the time the stock is [illegible] packed for shipment. Professor Symons of Maryland calls attention to the [illegible] that San José scale is not nearly as bad a pest from the average comm[illegible] orchardist's standpoint as is crown gall, yet the former is much more car[illegible] guarded against by our state inspection work. Professor Haseman of Miss[illegible] suggests that each state inspector draw up a list of insects "which he cons[illegible] of sufficient importance in his particular state to justify the quarantin[illegible] nursery stock infested with them," such lists to be published, or exchange[illegible] other state inspectors.

The following states inspect incoming shipments of nursery stock after [illegible] arrival in the state:—Arizona, California, Colorado, Massachusetts, Mo[illegible] Idaho, New York, Oregon, Washington, Utah and Texas. In this connect[illegible] following comments by Mr. T. O. Morrison, deputy commissioner of Hort[illegible] in Oregon are of interest: "I would like to see a uniform method or sys[illegible] inspecting nursery trees throughout the United States. Many of the sh[illegible] that come to our state bearing a printed certificate of inspection from [illegible] entomologist in the Middle West or East show that the stock of a nurs[illegible] sisting of several hundreds of acres was inspected on a certain day in [illegible] etc. Such a certificate is absolutely worthless and moreover is mislead[illegible] We accept such a certificate as meaning that the inspector casually walked [illegible] such and such a nursery on a summer day. I say this because we find any [illegible] of infection under such a certificate. A uniform system of inspection [illegible] would make the inspection certificate of more dependable value."

After careful consideration of the large amount of information and su[illegible] furnished by the state inspection officials and of the available informa[illegible] data in published reports concerning the inspection of nursery stock ship[illegible] destination, all bearing upon the actual value of inspection certificates, [illegible] offer the following recommendations:

1. We recommend that the section of Horticultural Inspectors officiall[illegible] the system of each state providing for the inspection of all nursery stock [illegible] from the states after its arrival within the state to which it is consigne[illegible]

2. Since it will undoubtedly be many years before such a system will [illegible]

by even a majority of the states, notwithstanding its desirability, we recommend, as a much needed reform of nursery inspection practices, the abandonment as soon as possible, of those features of nursery certification which are self condemned by the assembling of the facts as presented in this report.

We recommend more especially against the use of words in the certificates which necessitate mental reservations of any kind; if a limited number of pests are exclusively referred to by the inspector, such lists should accompany each certificate as a part thereof; if such pests as may be considered as dangerously injurious in the state without regard for outside sections are exclusively referred to by the certificate, such should be plainly indicated in the certificate.

4. We recommend that where local conditions require a special form of certificate for the sale and shipment of nursery stock wholly within the state, full consideration be given to a wording and style of certificate appropriate for the interstate shipments. In this connection we call attention especially to the styles of certificates now in use in Florida.

5. We recommend that insect pests and diseases which affect the roots of nursery stock and which cannot be observed by the inspector until the trees are dug, be plainly omitted from the certification, except where tree by tree inspections are made after the trees are removed from the ground.

6. We recommend that where lack of sufficient financial support prevents thorough inspection of the roots of nursery stock after the trees are dug, that such certificates or licenses as are provided the nurserymen be granted under strict written agreements concerning the separation and destruction of diseased or insect-infested trees at the time the trees are removed from the nursery rows. We call attention here to the system used in Illinois and in Arkansas.

7. We recommend as a condition for the issuance of a certificate covering nursery stock standing in the nursery, that the owner of the trees agree to eliminate as far as possible all crown-gall-infected trees and all stone fruit trees infested or injured by peach borer and trees of any kind infested with nematodes, and that the shipments upon which certificates are used be guaranteed to be free from visible infection or infestation to the extent of 95 per cent.

8. We recommend for the consideration of this section the following form of certificate as the basis for the adoption of a uniformly phrased general certificate covering interstate shipments:

This is to certify that the nursery stock of ——— ——————— consisting of ——— acres located at ——————— has been inspected by the undersigned or his representative, that the said ——————— has agreed to comply with regular requirements for the elimination of infested or diseased trees or plants as a condition of the issuance of this certificate, and is hereby authorized to use this certificate or a copy thereof on interstate shipments of the stock specified until ——————— unless revoked for cause. It is further understood and agreed that neither this certificate nor a copy thereof shall be used to attach to a package or parcel of trees or other living plants to be shipped by mail into states where provisions have been made for the inspection of imported trees or plants at destination.

Signed ———————.

I hereby certify that all provisions have been agreed to and the terms complied with in every detail.

Signed ———————.

9. We recommend that the foregoing information furnished by the va[illegible] spection officials and our recommendations be printed and placed before [illegible] bers of this section for final action at the next annual meeting of this sec[illegible] that in the meantime each official endeavor to remove objectionable feat[illegible] his certificates.

Respectfully submitted,

A. W. MORRILL,
FRANKLIN SHERMAN, [illegible]
F. L. WASHBURN,
Com[illegible]

Megilla Maculata. While cutting a large chestnut tree, April 20, in an obs[illegible] cavity, partially filled with leaf mould and in which there was still some frost, th[illegible] was found a ball or cluster of *Megilla maculata*, De G. The numbers exceeded si[illegible] but probably not one hundred and ten. I personally counted fifty-eight and s[illegible] other scattered specimens. They were lively although somewhat cold. Am[illegible] them was one specimen of *Adalia bipunctata* L. This hibernating cluster also sh[illegible] some mortality which apparently is significant. In one spot, adhering to a [illegible] punky wood, were three dead *Megilla maculata* De G. Furthermore, they show[illegible] some signs of mould. This may be secondary and not a feature of their death. It could not be said definitely that the hibernation occurred within the leaf mo[illegible] although apparently the insects had buried themselves.

BURTON N. GATES

A New South American Scientific Journal. Prof. Charles E. Porter, occupy- ing the chair of general zoölogy and applied entomology and also director of the re- cently established Museum and Laboratory of Economic Zoölogy at the Natio[illegible] Agricultural Institute of Santiago, Chili, has undertaken the publication of a [illegible] scientific journal under the title "Anales de Zoölogia Aplicada." This [illegible] to be especially devoted to original studies on species beneficial to and parasitic [illegible] man, domesticated animals and cultivated plants in America. The well known "Revista Chilena de Historia Natural," edited by Professor Porter, is being con- tinued, but only for systematic papers. The "Anales de Zoölogia Aplicada" w[illegible] be published quarterly, in 8°, on excellent paper, profusely illustrated with [illegible] figures and when necessary with plain or colored plates. Original contributions [illegible] American parasites (Protozoa, Vermes, Arthropoda), in English, French or Spanish will be accepted. Announcements of books, other scientific periodicals a[illegible] ments relating to the subject matter of the journal will be printed on colo[illegible] pages. The director wishes to exchange the "Anales de Zoölogia Aplic[illegible] with all special journals of economic zoölogy and entomology. The subscri[illegible] is 25 francs a year. Advertisements on colored pages 25 francs per pa[illegible] number. The address of the director of the new journal is: Prof. C[illegible] Porter, C. M. Z. S., F. E. S., Director de los Anales Zoölogia Aplicada, Casilla 297[illegible] Chile.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1914

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—Eds.

Separates or reprints will be supplied authors at the following rates:

Number of pages	4	8	12	16	32
Price per hundred	$1.50	$3.50	$4.25	$4.75	$9.00
Additional hundreds	.25	.50	.75	.75	1.50

Covers suitably printed on first page only, 100 copies, $2.00, additional hundreds $.50. Plates inserted, $.50 per hundred. Folio reprints, the uncut folded pages (50 only) $.50. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

There have been marked advances in the uses of insecticides in recent years and it is a pleasure to include in this number an article relating to soil fumigation. This is a difficult problem and one worthy of careful study. Enough progress has been made to suggest the possibility of a practical soil fumigant being developed for the control of subterranean pests of staple crops. It might be feasible to use such materials in connection with fall plowing, if land could not be safely planted within a few weeks after treatment. This is one of the weak points in entomological practice. It is to be hoped that the inherent difficulties will be overcome soon and a generally available soil fumigant found.

The interdependence of entomologists as well as the value of our insecticide batteries was shown by the developments of the last few weeks in New York state. A localized though widespread outbreak of the red-legged grasshopper and several associated forms was quickly controlled in threatened grain fields by the use of the Kansas bait, brought into notice only last year. Dying insects were to be seen within four hours after the distribution of the bait and within three days about three-fourths of the grasshoppers in a field were dead. Our eastern grasshoppers are rarely migratory and consequently there was not the need of general coöperation among farmers in the infested area as in the West, though united action is desirable and increases the value of the measures adopted.

Reviews

Traite D'Entomologie Forestiere, by A. Barbey. Berger-Levrault, Paris, France, 1913.

This volume, intended for foresters and woodland owners, contains brief [illegible] on insect anatomy and insect classification, then discusses the principal in[illegible] of each kind of tree used in forest planting, beginning with the conifers. [illegible] host tree the insects are treated as follows: attacking the roots; bark of [illegible] and branches; interior of the wood; branches; buds, and leaves.

The book contains 624 pages, 367 text figures, 8 colored plates, and a bibli[illegible] of 94 references to European literature. Many of the text figures are from [illegible] photographs and the plates are from drawings.

Though this volume is not indispensable to the forest entomologist in Am[illegible] is useful as a refference work, and therefore finds a place in departmen[illegible] Those engaged in the inspection of imported nursery stock, and those studying [illegible]pean pests liable to be brought into this country, will find this book useful, [illegible] haps therein lies its greatest value to American entomologists.

W. [illegible]

Die Forstinsekten Mitteleuropas. Ein Lehr- und Handbuch [illegible] K. Escherich. A new edition of Judeich-Nitsche, text-book [illegible]tral European forest entomology. Revised. Vol. I. General [illegible]troduction to the structure and life habits of insects, as well as [illegible] general fundamental principles of practical forest entomology. [illegible] 433 pp., 248 text figures. Berlin, 1914.

Although this volume appeared only this year it has quite an interesting [illegible] In 1841 Ratzeburg, the father of forest entomology in Germany, published [illegible] for private libraries and foresters a small volume entitled "Die Waldverde[illegible] ihre Feinde." So great was the demand for it, that in 1869 he issued a sixt[illegible] Each of the editions was revised and enriched with fresh observations. [illegible] revised edition was issued by Judeich in 1876. In 1885, Judeich & Nitsche [illegible] the first part of a completely revised and enlarged edition under the new title [illegible] though still designated "the eighth edition of Ratzeburg's" original work. [illegible] be noted that in the present volume Ratzeburg's name is absent from the [illegible]

Says the author in the preface: "About thirty years have now elapsed [illegible] first part of 'Judeich-Nitsche' appeared—thirty years full of activity and [illegible] in our science. Everywhere, primarily in North America, as a result of [illegible]nition of the profound significance of insects on life under our cultivatio[illegible] entomology has been studied with a hitherto unknown zeal and scientific [illegible] An enormous amount of new facts of general importance were thus broug[illegible] and some of the earlier views must either be more or less modified or enti[illegible] overboard, so that our science today presents an essentially different asp[illegible] places higher requirements upon the knowledge and skill of its represent[illegible] the science of thirty years ago."

Four volumes are contemplated, of which this is the first. This is more [illegible] as large as the corresponding part of the old edition, made necessary by [illegible]hensive treatment of the anatomy, physiology and developmental histo[illegible] sects and especially by the exhaustive presentation of the factors limit[illegible] (Chapter VI) and the fundamental principles of effective rational co[illegible] The last two subjects could not, in the author's opinion, "be treated wi[illegible]

thoroughness, as they represent the foundation of forest entomological practice. Whoever has learned to think correctly on these points will remain warned against gross errors in practice."

The chapter on insect-killing fungi was prepared by Dr. G. Lakon, while the "Rules of Cultural Means of Prevention" come from Dr. W. Borgmann of Tharandt.

A bibliography is given at the end of each chapter, listing the most important periodical works.

Special emphasis is laid on illustrations, of which the present volume contains more than double the number of those in the corresponding part of the old edition. Only comparatively few of those in the old edition are here reproduced (indicated by N at end of legend). The new figures are partly borrowed from other works and partly original.

The volume before us is divided into eight chapters with the following chapter heads:

Chapter I. Position of Insects in the System.
Chapter II. External Appearance of Insects (Morphology).
Chapter III. Internal Structure of Insects (Anatomy and Physiology).
Chapter IV. Reproduction.
Chapter V. Insects as a Natural and Economic Power in General and especially in reference to Forestry.
Chapter VI. Natural Limitation of Insect Increase.
Chapter VII. Prevention and Control of Insect Calamities.
Chapter VIII. General Survey of the System of Insects with a supplement: Guide to the Establishment of a Forest Entomological Collection.

The Chapter on Insects as a Natural and Economic Power covers the subject from so many angles that it abounds in data of exceeding interest. After a brief discussion of the average size of insects, the number of genera and species, the masses of individuals and their distribution in the various media, the author classifies the directions in which the activity of insects is specially important as follows:

1. They hasten the disintegration of dead organisms.
2. They destroy numerous living organisms and thus contribute to the maintenance of the organic balance;
3. They constitute the necessary source of food of many other animals;
4. They bring about cross fertilization of many plants;
5. They assist in the distribution of the plant world, and
6. They participate in soil building.

Of these, 1, 3, and 4 were discussed by the original authors (Judeich & Nitsche), 2, 5, and 6 being new additions. Of these, the last two are of interest, primarily because based on most recent studies.

In his discussion of the "*Degree of Destructiveness of Forest Insects*," the author enumerates the following influencing factors:

1. The biology of the given insect.
2. The tree species.
3. The age of the trees attacked.
4. The health condition of the plants.
5. The character of soil.
6. The weather conditions.
7. The season of the year in which the attack is made.
8. The sylvicultural conditions.
9. The geographical position.

Of these, the first one and the last two are not given, at least not in this connection, by Judeich and Nitsche. This is what the author has to say under caption 8 in its application to the United States:

"Difference of management has an important influence on the extent of ... The degree to which this is true we can see from the fact, for instance, that ... clean kept forests under normal weather conditions, etc., the barkbeetles are ... a menace; while in North America, where forest management in our sense ..., nothing of a clean forest management, is scarcely known, they are responsible ... greatest devastations in the forests, and in many localities the very existence ... forests is jeopardized by them."

His discussion of "Cultural Methods of Prevention" Professor Borgmann ... cludes thus:

"If we review the various methods which are founded in the first place ... bases of *location* and *sylviculture* and, in the second, on *forest management* and ... *utilization* respectively, it is not difficult to recognize in the composite the fundamental principle of all preventive measures that *in a well ordered management, ... fied by the principles of a natural sylviculture as well as by economic requirements ... free from a cut-and-dried one-sidedness, lies the best foundation for protection ... great insect calamities.*"

This is what Professor Escherich has to say regarding our Gipsy Moth Campaign:

"Thus, the gigantic campaign which the Americans are leading against the gipsy moth represents a great step forwards also for German forest entomology; ... I may safely say, the most important progress that our science of forest entomology had to record in the last decade. It is therefore quite necessary that the German entomologist should be informed about it and that he draw the corresponding knowledge from it."

Like its forebears, this work promises to be a fairly complete compendium of knowledge of forest entomology, especially as applied to cultivated forests. ... yet, a careful perusal of the methods of prevention and control as given in the ... before us, particularly as to the details of the execution of the latter, thorough ... comprehensive as they are from the viewpoint of forest conditions and practice ... western Europe, as regards the United States one is led to the inevitable conclusion that not only the principal forest insect depredators but the very forest conditions in the United States are so radically different from those prevailing in Europe ... least for the present, the practices prevailing there are applicable here only ... limited extent.

JACOB KOTINSKY

May 26, 1914.

A Textbook of Medical Entomology by W. S. PATTON and F. W. CRAGG. (Christian Literature Society for India, London, Madras and Calcutta, 1913, quarto) pp. i-xxxiv, 1-764, pls. LXXXIX.

This large volume covers a practically unoccupied field and relates to one of the most important phases of economic entomology. Within its covers we find a comprehensive and carefully prepared summary of what is known concerning ... insects. The authors have been careful not to draw the lines too closely ... have some regard for space limitations. The book is designed particularly ... cal workers in the tropics and is a "guide to a study of the relations between ... pods and disease." The information presented is conspicuous by its ... most text and reference books on economic entomology and was of necessity ... from numerous and widely scattered sources; in some instances little was ... except that published by the earlier students of insect anatomy. The authors ... been more concerned in elucidating, and rightly so in this instance, practical ... value to the experimenter and field worker, rather than the improvement of ...

systems and the harmonizing of discordant elements in anatomical nomenclature important though the latter may be.

The first chapter outlines the history of entomology as a branch of preventive medicine, summarizes the classification of the arthropods and defines the principal protozoa. The next two chapters, over 140 pages, discuss the external and internal anatomy respectively. The first is important as an aid to the identification of insects, while a knowledge of the internal anatomy, both macroscopic and microscopic, is a prerequisite for the satisfactory recognition of pathogenic conditions and the identification of the causative organism.

Certain pathogenic Diptera and their close allies, such as the Culicidæ, Tabanidæ, some Muscidæ, are discussed in detail. Members of the Siphonaptera, Rhynchota, Anoplura, Ixodidæ and Acari are similarly treated. The organism's relation to disease, its natural parasites, external anatomy, bionomics, methods of rearing in the laboratory, are some of the matters discussed. Each of the principal chapters concludes with a well-selected and classified biliography.

The investigator must first identify the insect. We have in this volume a number of keys from various sources for the recognition of species. These are supplemented by descriptions and numerous illustrations. Careful directions are given for the dissection of the various forms. The many practical hints for handling and rearing are invaluable and exceedingly suggestive. This work is a necessity to all students of the medical aspects of applied entomology, particularly in tropical and subtropical regions, while those in other sections will find much that is very serviceable. As a reference work, this publication should appeal strongly to the general economic entomologist and to all giving instruction of a collegiate grade.

Flies In Relation To Disease, Non-bloodsucking Flies, by G. S. Graham-Smith. Cambridge. The University Press, 1913, pp. i-xiv, 1-292, 24 pls. 32 text figs.

This is a critical and very conservative account of the part non-bloodsucking flies play in the dissemination of disease, as shown by available evidence. Furthermore, the author lays a substantial foundation for subsequent investigations. Chapters five and six, dealing with the structure of the proboscis and the functions of the anterior part of the digestive system, are particularly strong and worthy of careful study. They constitute a most fitting introduction to the chapters on habits, methods of observing flies in captivity, and the distribution of bacteria, all replete with significant facts and containing much of value respecting methods. The relation of flies to the more important diseases is illuminated with much original data and is considered without prejudice to the organisms under discussion, the author refusing to draw conclusions not amply supported by trustworthy evidence. He emphasizes the need of more epidemiological data before drawing general conclusions.

The entomologist, both economic and systematic, will be particularly interested in certain portions of the anatomical discussions, the evidence relating to the dissemination of disease and that in regard to myiasis. The physician and others with similar interests will find in this small volume an excellent summary and a practical introduction to a difficult and complex subject.

Current Notes

Conducted by the Associate Editor

Mr. J. R. Horton, of the Bureau of Entomology, recently visited Mobile, Alabama, to investigate the Argentine ant in its relation to citrus trees in that region.

Messrs. H. G. Barber, Charles W. Leng and F. B. Watson, of New York, will visit Porto Rico this summer to assist in the survey of the island, especially studying the insects.

Professor A. L. Melander, who has been on leave of absence studying at the Bussey Institution, Harvard University, for the past year, has returned to Pullman, Washington.

Professor A. B. Cordley, Dean of the Oregon School of Agriculture at Corvallis, and formerly entomologist, has recently been appointed Director of the Oregon Station.

Professor W. M. Wheeler of Harvard University is absent on a visit to Australia where he will attend the meetings of the British Association for the Advancement of Science, and collect and study the Australian species of ants.

Professor E. F. Hitchings, now associate professor of horticulture, University of Maine, formerly state entomologist, emerged about June 1 from five weeks in a Boston hospital and is recuperating during the summer at Enfield, Me.

Mr. F. L. Simanton has been placed in charge of the Bureau of Entomology laboratory at Winthrop, Me., to continue especially the codling moth investigations there undertaken last by Mr. E. H. Siegler.

Mr. John W. Bailey, a student of the Mississippi Agricultural College, who has been appointed temporary field assistant in the Bureau of Entomology, will be in charge of the work at Brownsville, Tex., in the absence of Mr. High.

Mr. M. E. MacGregor, a Carnegie scholar, has been engaged as a collaborator, Bureau of Entomology, in the investigation of the possible insect transmission of pellagra. He will be associated with Mr. A. H. Jennings at Spartanburg for several months.

Mr. R. H. Hutchison, of the Bureau of Entomology, has returned to Washington from New Orleans. He will be engaged on experiments with the house fly during the season. Mr. A. W. J. Pomeroy will be associated with him in this investigation.

Mr. C. H. T. Townsend, who has been director of the Entomological Experiment Station at Lima, Peru, returned to the United States July 1, and is now connected with the United States National Museum at Washington, where he should be addressed.

Mr. E. W. Geyer of the New Mexico Agricultural College, has been [illegible] by the Bureau of Entomology to continue the codling moth investigati[illegible] way during the past two seasons in the Pecos Valley in New Mexico, and w[illegible] were interrupted by the untimely death of Mr. A. G. Hammar.

Mr. J. S. Houser, of the Ohio Station, visited New Jersey, New York and the New England States early in June to study the methods employed in dealing with the gypsy and brown-tail moths and other shade tree insects. Mr. Houser visited several entomologists on this trip.

Mr. Loren B. Smith of Cornell University, formerly of the Nova Scotia Agricultural College, has been appointed Assistant State Entomologist of Virginia. Mr. Smith will be located at the Virginia Truck Experiment Station at Norfolk, and will take charge of the work on the truck crop insects.

Mr. T. E. Holloway, of the Bureau of Entomology, will spend several months in Europe during the summer, visiting Italy, France and Germany. He will be accompanied by Mr. G. N. Walcott of the Porto Rico Board of Agriculture.

Mr. F. M. Wadley, a student of the Kansas State Agricultural College, is assigned as temporary field assistant in the Bureau of Entomology to coöperate with Mr. F. B. Milliken at Garden City, Kansas, in work on truck crop insects, especially on insects injurious to sugar beets.

Mr. Mason, a Carnegie scholar, who has been in this country for about a year, recently having studied at Cornell University, has been appointed Government Entomologist in Nyasaland. He spent some days in Washington during the month preparatory to leaving for his new post.

Hearings were held by the Federal Horticultural Board, on May 15, regarding the pink boll worm which occasionally comes into this country in cottonseed in bales of lint; on June 22, regarding the extension of the quarantine against the gypsy and brown-tail moths in the New England States.

Mr. John A. Grossbeck, a specialist in geometridæ, and for the last few years connected with the American Museum of Natural History in New York, formerly assistant to Dr. J. B. Smith at the New Jersey Station, died in Barbadoes, British W. I., April 8, 1914. Mr. Grossbeck was born in Paterson, N. J., February 2, 1883.

Mr. Jacob Kotinsky, who was formerly Entomologist of Hawaii, had been appointed entomological assistant in the United States Bureau of Entomology and assigned to the Division of Forest Insect Investigations of which Dr. A. D. Hopkins is in charge. Mr. Kotinsky's present address is Silver Spring, Md., R. R. No. 3.

Mr. M. M. High, entomological assistant, Bureau of Entomology, who has been working on truck-crop and stored-product insect investigations, especially on onion pests, at Brownsville, Tex., will resume his midsummer headquarters at Knox, Ind., where he will continue on the same class of insects under different climatic and soil conditions.

Mr. [illegible] A. Miller, graduate 1908 of the Texas A. and M. College, who has been Plant Pathologist and Assistant Entomologist for the past two years, has taken up work with the L. & N. Ry., in the capacity of horticulturist, plant pathologist and entomologist. Mr. Ed. L. Ayers, B.S., 1914, of the A. and M. College has been appointed to fill Mr. Miller's place in the Texas Department of Agriculture.

Mr. [illegible] J. Newcomer, of Leland Stanford University, has been employed by the Bureau of Entomology and assigned to work on deciduous fruit insects in the Wenatchee Valley, Washington. In coöperation with Mr. D. F. Fisher, representing the

Bureau of Plant Industry, a special investigation is being made of Stigm the apple.

Mr. Boyd L. Boyden, scientific assistant in the Bureau of Entomology, formerly employed at Whittier, Cal., where he was associated with Messrs. R. S. Woglum and John E. Graf, recently coöperating with the latter in work on affecting sugar-beet and other crops, will take headquarters at Oxnard, Cal., continue investigations on sugar-beet and bean insects.

Owing to injury to citrus trees in California by the citrus mealy bug species, it is proposed to establish a field station of the Bureau of Entomology to investigate these pests and devise means for controlling them. This work in charge of Mr. R. S. Woglum, and when he has found a suitable location for the new station, the one at Whittier will be discontinued.

Mr. Arthur H. Rosenfeld, director and entomologist of the Tucuman Argentine Agricultural Experiment Station and a foreign member of the American Association of Economic Entomologists, was named Professor of Entomology in the University of Tucuman by government decree last April. Mr. Rosenfeld was also made Fellow of the American Association for the Advancement of Science at its Atlanta meeting.

At a recent meeting of the board of trustees, Maryland Agricultural College, Professor T. B. Symons, State Entomologist and dean of the School of Horticulture was appointed director of the Extension Division which has recently been formed at the Institution. Professor Symons will, however, continue to direct the entomological work in the state. Mr. E. N. Cory, associate professor at the same Institution was promoted to Professor of Zoölogy.

In the Division of Apiculture, Bureau of Entomology, Dr. N. E. McIndoo went to Winchester, Va., to coöperate with Mr. E. B. Blakeslee of the Deciduous Fruit Insect Investigations, in a study of the effects on honey bees of spraying fruit trees while in full bloom. To obtain further data he will go to Winthrop, Me., to the branch laboratory under the direction of Mr. F. L. Simanton, about June 1. Dr. G. F. White, who spent the winter in Ithaca, N. Y., has returned to Washington. Mr. George S. Demuth closed up the work on the wintering of bees in Philadelphia about the end of May.

In response to a demand from grape growers in the Lake Erie Valley, a laboratory has been re-established by the Bureau of Entomology, at North East, Pa., where further investigations of grape insects and other deciduous fruit insects will be made. Especial attention will be given to the grape berry moth, continues to be a grape pest of first importance in that general region. Isely, of Cornell University, has been employed to look after the gene and field work, and Mr. R. A. Cushman has been transferred from the laboratory to North East, Pa., and will have charge of the investigation of the grape berry moth, to which it is proposed to give more attenti been possible heretofore. Mr. Cushman will also make a study of th Chalcis, which, in recent years, has been the cause of considerable con apple growers.

Mailed August 15, 1914.